B. HISTORICAL SETTING

1. General

Imperial Irrigation District was organized in July 1911 under the California Irrigation District Act for the purpose of acquiring the rights and properties of the then-bankrupt California Development Company (C. D. Company) and its Mexican companies. Leaders in the Valley decided that a public district could best cope with the numerous problems - silt, drought, floods and litigation - that had led to the failure of the C. D. Company. As organized, the District included 513,368 acres within its boundaries, 65,000 acres more than that covered by the mutual water companies' stock.

Much has been written about the early development of Imperial Valley and the problems confronting those early developers, so only a brief summary is given here. The idea of diverting the Colorado River to irrigate the desert wastes of the valley was perceived before the Civil War. Dr. O. M. Wozencroft was probably the first to recognize the possibility as he crossed the Colorado Desert en route to San Francisco in search of gold in 1849. He died in 1887 without seeing his dream fulfilled, but he had stirred up considerable interest. In 1895, several water appropriations were filed by individuals to divert Colorado River water to irrigate lands in "that portion of San Diego County - known as "New River Country."

The C. D. Company was formed in 1896, after four years of extensive investigation and surveys by C. R. Rockwood. Efforts to finance the project developed by Rockwood were unsucessful until George Chaffey agreed to take charge. Mr. Chaffey, the developer of Etiwanda and Ontario, had declined in 1982 to work with Dr. Wozencroft on the plan because he thought white men could not withstand the summer heat in the desert. He changed his mind after his experience in irrigation development in Australia. Rockwood and his associates in the C. D. Company decided to call the area, variously known as the Colorado Desert, Salton Basin and New River Country, the name we know today, Imperial Valley.

Excavation of a canal and construction of headworks on the Colorado River near Pilot Knob began in 1900, and in 1901 the first diversions were made to serve about 1,500 acres of crops. The Imperial Canal, also known as the Alamo Canal, ran through Mexico about 60 miles before crossing into the United States east of present-day Calexico. Within about three years silting of the headworks and upper reaches of the Canal led to the excavation of a temporary bypass channel without a headgate structure about four miles downstream in Mexico.

Unseasonable flood water on the Colorado and Gila Rivers in the fall of 1904 broke into the bypass and down the Alamo Canal, and for almost two years practically the entire flow of the Colorado River poured into the Salton Sink forming the Salton Sea. The struggle to close the break is a story in itself, but by February 1907 the final effort by the Southern Pacific Company was successful in returning the Colorado to its normal channel. Southern Pacific being the largest creditor, then took over operations of the C. D. Company and its Mexican subsidiary company.

During the next several years, physical, financial, international complications and legal problems plagued the project, and the settlers decided the best solution was to form a public state agency, resulting in formation of the Imperial Irrigation District in 1911.

Formation of the District did not solve all of the problems immediately. In fact, it was not until 1916 that financial and legal problems were settled so that the District could acquire the properties of the C. D. Company and its Mexican subsidiary from the Southern Pacific Company (S. P. Company) and take over operations of the canal system financed by the proceeds of the First Bond Issue of 1915 in the amount of $3.5 million. A new Mexican company "Compania de Terrenosy Aquas de la Baja California, S. A." (Compania) was formed. The capital stock of the Compania was placed in the names of the District board members, who acted as trustees.

Some of the important actions which the District took between 1915 and 1930 are listed below:

a. Highlights: 1915 - 1930

1915 Inclusion of 70,700 acres making total District area 584,068 acres.

1916 Report No. 1 by Consulting Board (G.G. Anderson and C. E. Grumsky) recommending a new headgate and main canal improvements.

1917 Report No. 2 listed 43 items including those in Report No. 1 for two-year improvement program.

Second Bond Issue sold in amount of $2.5 million. Much of the planned work, including construction of Rockwood Heading, was accomplished in 1917 - 1918.

1918 Two more reports submitted and adopted. Third Bond Issue, also for $2.5 million sold, and work accomplished through 1921 included improvements at Andrade, River levee work in Mexico, and the canal system both in Mexico and Imperial Valley.

1920 Drainage study funded by portion of Third Bond Issue.

1922 Fourth Bond Issue (the last issue of District General Obligation Bonds), in amount of $7.5 million, sold between 1922 and 1925 for purpose of purchasing the Mutual Water Companies ($5 million) and constructing a deep drainage system.

Absorption by the District of all existing Mutual Water Companies was completed by March 1923 at a total cost of $4.7 million.

1923 District solely responsible for:

- The protective levee system;
- The diversion, transportation, distribution and delivery of water from the Colorado to individual water users, including cities and towns, within a service area of about 540,000 acres;
- Construction, operation and maintenance of irrigation and drainage systems;
- Operations of the Compania in Mexico.

1917-28 District constructed 234 miles of deep drains using Fourth Bond Issue Funds plus General Funds.

1929 First tile drains installed.

1930 Drainage system comprised 234 miles of deep drains, 740 miles of lateral drains. Individual farmers had installed 10 miles of tile drains.

On December 1, 1932 the District executed the "Contract for Construction of Diversion (Imperial) Dam, Main Canal and Appurtenant Structures and for Delivery of Water" with the United States. During the decade of the 30's while Hoover Dam, Imperial Dam and the All-American Canal were being constructed, the District struggled with very severe financial dif-ficulties, but by 1940 the District's position began to improve. However, due to those difficulties the District's canal and drainage systems deteriorated, and it took several years more to get them back in shape.

A severe storm in September 1939 and the intense earthquake of May 18, 1940, caused extensive damage throughout the Valley, and considerable time and expense were incurred in repairing damaged District facilities.

Gradual improvement of the irrigation and drainage systems took place during the decades of the '50's, '60's, and '70's. In 1947 the District signed an agreement with Imperial County providing for installation and/or replacement of road crossings of the District's systems. The agreement, still in effect today, provided that the District make the installation of pipe culverts (aka "siphons"), with the County paying for materials. Agreements were also signed during this period with the Southern Pacific Railroad Company and several cities for installation of pipe.

Listed below are some of the important actions taken by or affecting the District since 1930:

b. Highlights - 1935 - 1984

1935 First Storage of water behind Hoover Dam.

1936 District entered power business to develop hydroelectric poten tial on All-American Canal.

1938 Imperial Dam, on Colorado River 10 miles northeast of Yuma, Arizona, completed.

1942 All-American Canal became sole source of water for Imperial Valley.

1947 Control of All-American Canal west of Pilot Knob turned over to District.

1947 U.S. Bureau of Reclamation of the Department of Interior and Imperial Irrigation District entered into an agreement whereby the District would undertake to determine the practicability of East Mesa lands for agricultural use.

1952 District assumed control of remainder of All-American Canal, from Imperial Dam to Pilot Knob, and first 50 miles of Coachella Branch.

1961 District ends 50-year operation in Mexico by selling holdings to Mexican government.

1964 U.S. Supreme Court decree in the Arizona-California suit apportions 2.8 million acre-feet of Colorado River water to Arizona, 4.4 million to California, and 300,000 to Nevada, subject to availability.

1967 District taxes on land discontinued. Board also voted to pay off property bonded indebtedness (irrigation bonds) of $2,932,000.

1971 Favorable judgment rendered in 160-acre land limitation suit in U.S. District Court.

1976 First water regulating reservoir, located on East Highline Canal, placed in service.

1977 Second reservoir, located on Westside Main Canal, added to system early in the year.

1980 Third regulating reservoir, located on Central Main Canal, put into service.

In a unanimous opinion, the U. S. Supreme Court in June exempted Imperial Valley from the 160-acre limit, overcoming a 1977 Ninth Circuit Court of Appeals ruling and ending 10 years of legal battles.

1982 Drop No. 5 Hydroelectric Plant on line: other hydro plants scheduled for construction.

1983 Fourth regulating reservoir, located on Rositas Supply Canal, completed.

1984 Two hydroelectric plants added to the four existing plants on All-American Canal.

2. Financial Background

The District's budget for 1984 projected total expenditures of nearly $104 million, about $23 million for water operations and $81 million for power. Total combined revenue was projected to be slightly over $105 million. The three major sources of revenue are:

Sales of water
Water Availability Charge
Sales of electrical energy

Additional sources are special assessments on excess tailwater, charges for gate tampering, rents, interest, and several miscellaneous sources.

Anticipated revenue for 1984 water operations, estimated in late 1983, was as follows:

Water Service Charges - 2.2 MAF @ $9.00/AF	$19,800,000
Water Availability Charges: 536,000 acres @ $1.90/AF	1,018,500
Water Conservation Charges	700,000
Pipe Charges and Small Acreage	175,000
Rentals	563,200
Interdepartmental Charge (50% of A.A.C. payment of $750,000, less 8% of Net Power Proceeds)	334,500
Interest Income @ $8.75%	750,000
Other Revenue	100,000
Total Estimated Revenue	$23,441,200

Actual revenues for operation of the Water Department during 1982 and 1983 were as follows:

Source	Amount ($1 000)*	
	1982	1983
Water Sales	$17,100	$19,649
Water Availability Charge	1,008	1,000
Interdepartmental Charge	334	334
Power Sales	(364)	(418)
Miscellaneous	197	842
Totals	$18,275	$21,407

*Reference: Audit Report dated February 28, 1984, by Calderon, Jaham & Osborn, and Peat, Marwick, Mitchell & Co., a joint venture, Certified Public Accountants.

The current water rate (Schedule No. 1, "General Agricultural and Municipal Service"), in effect since August 1, 1983, is $9.00 per acre-foot. The current Water Availability charge (Schedule No. 6, "Stand-by Service") is $3.80 per acre. In January 1985, this charge is scheduled to be reduced to $1.90 per acre.

The basic water rate has been increased about threefold over the past 10 years, from $2.70/A.F. in 1974 to $9.00/A.F. at present, mainly due to inflation, but also resulting from expansion of the District's water conservation program. Considerable expenditures were made during this period to repair extensive damage to District facilities resulting from two tropical storms and the 1979 earthquake. Finally, an unexpected problem arose when, in 1977, the noxious aquatic weed, hydrilla, was discovered growing in a section of the All-American Canal, and has since spread through the entire Westside Main Canal and lateral system. Although the District has received substantial financial aid from the state and federal governments to help eradicate this dangerous weed, District expenditures in personnel and equipment have been significant.

Traditionally, the District Board of Directors has established the water rate structure to meet anticipated expenditures, primarily to operate and maintain the irrigation and drainage systems so that water can be delivered to meet water users' orders, at reasonable costs.

Funding of past and current projects related to water conservation has been accomplished using a portion of revenues from water sales, i.e., water tolls. For example, in June 1975, the Board adopted Resolution 35-75, which, among other things, established an Irrigation Capital Improvement Fund, into which a 50-cent charge for each acre-foot of water sold was to be deposited. This fund was to be used "for the concrete lining program and for no other purpose."

In July 1976, the Board adopted Resolution 49-76 which established a Water Conservation Fund, into which a 75-cent charge for each acre-foot of water sold was to be deposited, with moneys from this Fund to be used for the 13-point water conservation program as set forth in Resolution 45-76.

Subsequently, in January 1979, Resolution 1-79 combined the two funds described above into one, retaining the Water Conservation Fund (i.e., $1.25/AF).

In May 1981, Resolution 26-81 provided for an increase in water rates of $1.00/AF, all revenue derived from said increase to be deposited in a "Special Water Conservation Fund" specifically to cover costs of an expanded water conservation program.

In 1984, the two funds were consolidated, and today all water conservation projects are paid for from the "Water Conservation Fund." As of October 31, 1984, this fund contained $3.47 million and is expected to increase slightly by the end of the year.

In a "normal" year, when water sales of 2.5 MAF are expected, revenues from the $1.75/AF allocated to the Water Conservation Fund will amount to $4.375 million.

Water funds held by the District in various accounts totaled $12.4 million as of October 31, 1984, and are expected to be only slightly lower by year's end.

3. Cultural Development

The economy of Imperial Valley is almost entirely dependent upon irrigated agriculture. Only 84 years ago, however, the Valley was raw desert. Spanish explorer, Juan Bautista de Anza, in his trek through the area last century, called it "La Jornada de Los Muertos," the Journey of the Dead.

Although the idea of reclaiming the desert with Colorado River water was conceived before the Civil War, actual development did not begin until 1900, and the first water was diverted to the Valley in June 1901.

For the first 40 years or so, much of the farming was speculative due to many problems such as drought, floods, silt, salt, and economic conditions, not to mention heat.

With electrification in the late '30's, and the development of the evaporative cooler (aka desert cooler and swamp cooler), living conditions improved, stimulating rural home building, as well as growth in the towns and cities.

By 1900, the populaton of Imperial County was 72,105, increasing to 92,100 in 1980. El Centro is the largest city, with Brawley as the second largest.

Historical and projected population is shown in Table II.3 for the seven cities and towns in Imperial Valley and the County totals. The projection for the year 2000 was furnished by the Imperial County Planning Department, with the breakdown by cities based on projected percentages.

TABLE II.3

HISTORICAL AND PROJECTED POPULATION
CHARACTERISTICS OF IMPERIAL COUNTY, CALIFORNIA

	1960	1980	2000	Percent Change 1960 to 1980	Percentage of 1980 County Population
Communities:					
Brawley	12,703	14,946	22,000	18	16
Calexico	7,992	14,412	21,000	80	16
Calipatria	2,548	2,636	4,000	3	3
El Centro	16,811	23,996	35,000	43	26
Holtville	3,080	4,399	6,000	43	5
Imperial	2,658	3,416	5,000	29	4
Westmorland	1,404	1,590	2,000	13	2
Unincorporated Imperial County	25,000	26,715	39,000	7	29
Imperial County	72,105	92,110	134,000	28	100

Sources: 1960 and 1980 data from the U. S. Department of Commerce, Bureau of the Census.

2000 data from the Imperial County Planning Department

Trends in employment, from U. S. Census data, are shown in Table II.4. Unemployment in Imperial County has been running extremely high in recent years, being in the range of 30 to 40 percent.

Gross income from agriculture, as determined annually by the County Agricultural Commissioner, has been approaching the $1 billion mark for several years, hitting a peak of $837 million in 1979. The County ranks as one of the top farming counties in the United States.

The 1983 gross income was $755,166,000, not including payment-in-kind (PIK) payments estimated to be $23 million. Agriculture continues to be highly diversified with more than four dozen crops grown. Livestock, especially cattle, contributes about one-third to the total agricultural economy.

Table II.5 shows yearly gross agricultural income for 1981 through 1983, taken from the 1983 Report of the Imperial County Agricultural Commissimer. The values are for the entire County, including a small portion of the Palo Verde Valley, and the Bard-Winterheaven area.

Several other facts and figures for 1980, furnished by Imperial County, which add to the understanding of socioeconomic characteristics, are shown in Table II.6.

TABLE II.4

INDUSTRY EMPLOYMENT TRENDS BY PERCENTAGE OF LABOR FORCE
IMPERIAL COUNTY, CALIFORNIA

Industry	1960	1970	1980
Agriculture	39	19	38
Mining	0	0	0
Construction	3	5	3
Manufacturing	6	7	5
Transportation, Communication, and Public Utilities	8	9	3
Trade Industries	18	24	18
Finance, Insurance, and Real Estate	2	3	2
Services	17	24	9
Government	7	9	22

Source: U. S. Department of Commerce, Bureau of the Census.

Table II.5

Imperial County Agriculture
1983 3/

Gross Income

RECAPITULATION 1983

	1981	1982	1983
Apiary Products	1,410,000	2,676,000	2,792,000
Field Crops	*303,909,000	241,614,000	255,976,000
Fruit and Nut Crops	6,242,000	4,360,000	5,794,000
Livestock and Dairy	225,990,000	216,875,000	244,718,000
Seed and Nursery	36,412,000	28,712,000	26,275,000
Vegetable Crops	153,939,000	267,743,000	219,611,000
TOTAL	*727,902,000	761,980,000	755,166,000

*Adjusted Total

MILLION DOLLAR CROPS FOR 1983

Cattle	$ 232,787,000
Alfalfa	104,695,000
Lettuce	71,048,000
Wheat	45,296,000
Cantaloupes	37,967,000
Carrots	33,307,000
Sugar Beets	32,865,000
Cotton	32,120,000
Alfalfa Cube & Dehydrated	22,697,000
Mixed Vegetables	12,305,000
Broccoli	9,991,000
Bermuda Grass Seed	8,043,000
Melons (Other)	7,947,000
Total Pasture	7,890,000
Alfalfa Seed	7,400,000
Watermelons	7,368,000
Sheep	7,345,000
Asparagus	7,064,000
Onion (Processor)	$ 6,704,000
Tomatoes (Market)	6,283,000
Tomatoes (Cannery)	6,275,000
Vegetable, Flower Seed & Nursery Stock	5,867,000
Onions (Market)	5,298,000
Squash	4,521,000
Cotton Seed	4,081,000
Sudan Grass Hay	3,352,000
Fish Products	3,153,000
Certified Seeds	2,826,000
Dates	2,065,000
Lettuce (Other)	1,874,000
Lemons	1,846,000
Honey	1,807,000
Baled Straws	1,659,000
Wheat Seed	1,302,000
Misc. Livestock	1,022,000
Cabbage	1,014,000

3/ From 1983 annual crop report of Imperial County Agricultural Commissioner

TABLE II.6

SOCIOECONOMIC
FACTS AND FIGURES IN 1980
IMPERIAL COUNTY, CALIFORNIA

Annual Growth Rate	2.3%
Percent of State Population	0.4%
Percent Hispanic Population	55.8%
Percent White Population	38.3%
Civilian Labor Force	42,637
Percent of Private Land Ownership	40.0%
Percent of Government Land Ownership	60.0%
Industrial Acreage	1,500
Median Household Effective Buying Income	$15,531

Source: County Administrative Office and El Centro Chamber of Commerce

CHAPTER III

DESCRIPTION OF WATER SYSTEM

A. INTRODUCTION

This chapter discusses the District's water conveyance system, and the agricultural systems operated by Imperial Valley farmers, which utilizes in excess of 95 percent of the water delivered through the conveyance system. A cursory description of municipal, industrial, and recreational water uses is also presented.

B. DISTRICT SYSTEM

1. Facilities

a. IRRIGATION SYSTEM

Imperial Dam serves as a diversion point where Colorado River water is delivered to users in California, Arizona and Mexico.

Water is conveyed from the Colorado River to Imperial Valley via the All-American Canal. Prior to being discharged into the All-American Canal, water is passed through desilting basins to clarify the water. The desilting basins are 540 feet wide and 770 feet long with 72 scrapers designed to remove 70,000 tons of silt per day.

The 80 mile long All-American Canal was built by the Bureau of Reclamation in the 1930's. Excavation got underway in 1934, after many years of lobbying by local residents. The first scheduled delivery of water by the new canal was in October 1940, and by 1942 the Valley was drawing its entire supply from the All-American Canal. The Canal has a capacity of 15,555 cfs at Imperial Dam, a maximum width of 232 feet at water surface, a 160-foot bottom width, and a depth of 20.6 feet. The system operates by gravity. Imperial Dam has an elevation of 181 feet above sea level, whereas Calexico on the western end of the Canal is at sea level.

Over the past ten years, the Imperial Irrigation District has diverted an average of 2.75 MAF of water annually during the past 10 years, as shown in Table III.1. The average water conveyance efficiency for that period was 90.7 percent.

Several main canals feed off the All-American Canal: the East Highline, Central Main, Westside Main and New Briar Canals. Service to Imperial Valley is provided via these four main District canals or directly from the All-American Canal. The five systems are shown in Exhibit III.1.

Delivery of water to the eastern portion of the Imperial Valley is made through the East Highline Canal. Starting at the All-American Canal 12 miles east of Calexico, it runs northwest along the edge of the sand dunes and base of the Chocolate Mountains to a point approximately 10 miles south of the Riverside County Line. No portion of the East Highline Canal is concrete lined. Approximately 250,000 acres are served from the East Highline Canal, together with the Rositas Supply Canal and Vail Supply Canal. This area generally slopes west to the Alamo River.

Between the Alamo River and New River the Central Main Canal serves approximately 103,000 acres of the central portion of the Imperial Valley. Commencing at the All-American Canal, just east of Calexico with a capacity of 1,300 cfs, it runs to a point one mile south of the Brawley city limits, for a total distance of 26.5 miles. There it comprises the heading of the Rockwood Canal which continues to the Vail Supply Canal at the North End Dam. The Central Main Canal is completely unlined.

Table III.1

IMPERIAL IRRIGATION DISTRICT

Table : Distribution of Water Within Imperial Unit

1974 - 1983

ACRE-FEET X 1,000

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	10-Year Average
To IID at Drop #1	3072	3001	2784	2693	2672	2803	2769	2769	2516	2417	2,750
Loss, Drop #1 to EHL	75	58	33	22	24	8	34	23	19	28	32
Loss, EHL to WSM	15	9	19	18	23	12	30	21	17	28	19
Gross A.A.C. Loss (2+3)	90	67	52	40	47	20	64	44	36	56	52
Canal Loss and Regulation	198	222	207	190	170	194	172	219	228	180	198
Total IID Losses (4+5)	288	289	259	230	217	214	236	263	264	236	250
Spill for System Regulation	5	7	7	6	10	11	8	6	4	1	7
Total Loss & System Regulation (6+7)	293	296	266	236	227	225	244	269	268	237	256
Total Deliveries to Users (1-8)	2779	2705	2518	2457	2445	2578	2525	2500	2248	2180	2,494
Water Conveyance Efficiency (100x9/1)	90.46	90.14	90.45	91.24	91.50	91.97	91.19	90.29	89.35	90.19	90.69
Gross Acres of Crops	573.5	585.5	613.0	565.0	567.0	576.5	588.0	600.5	594.5	501.8	576.53
Net Acres Irrigated	450.0	456.5	458.5	460.0	452.0	460.0	460.5	464.5	465.5	445.9	457.34

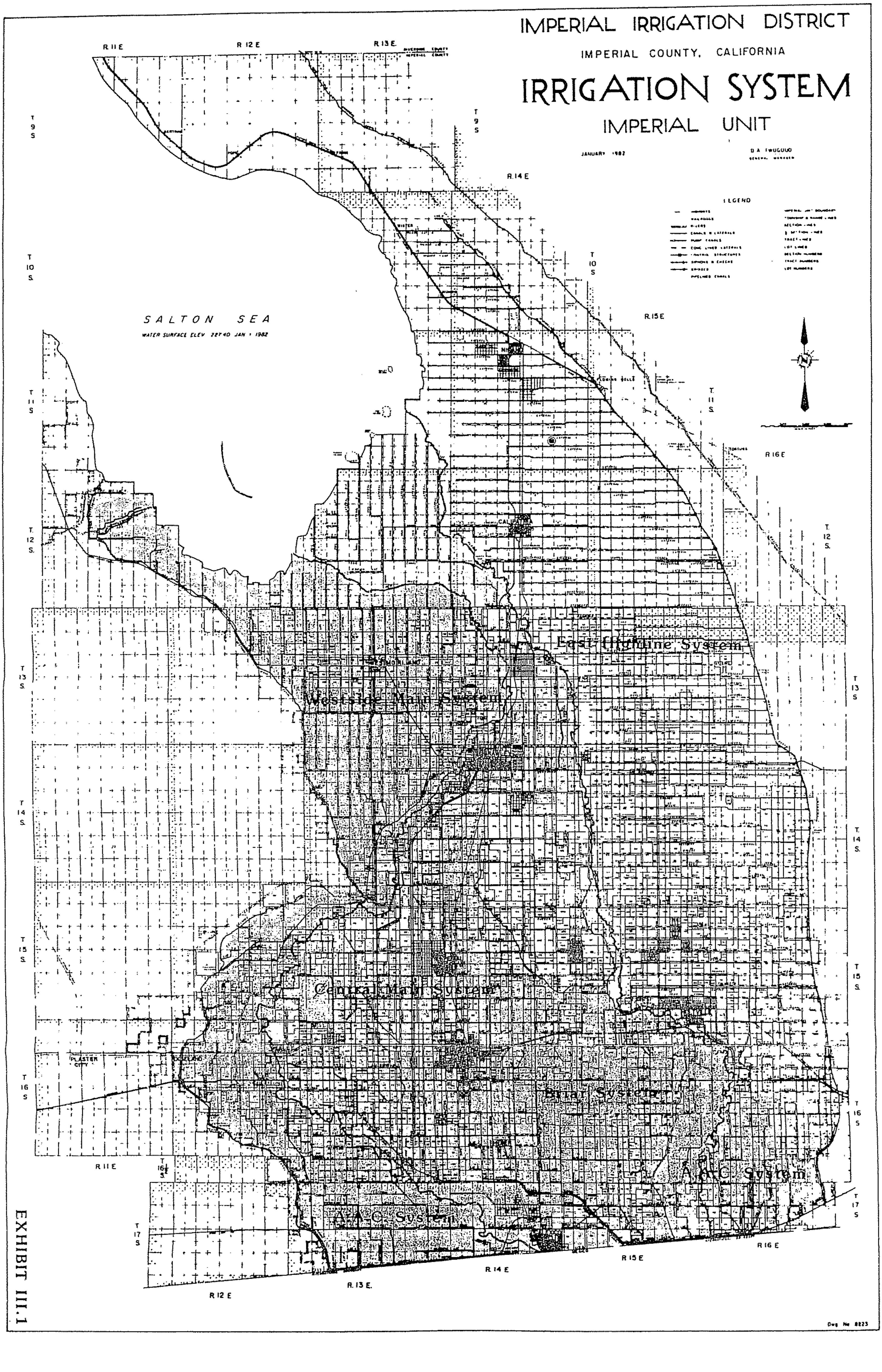


EXHIBIT III.1

This area is generally flat, necessitating laterals that are constructed above the natural surface in order to provide sufficient pressure head.

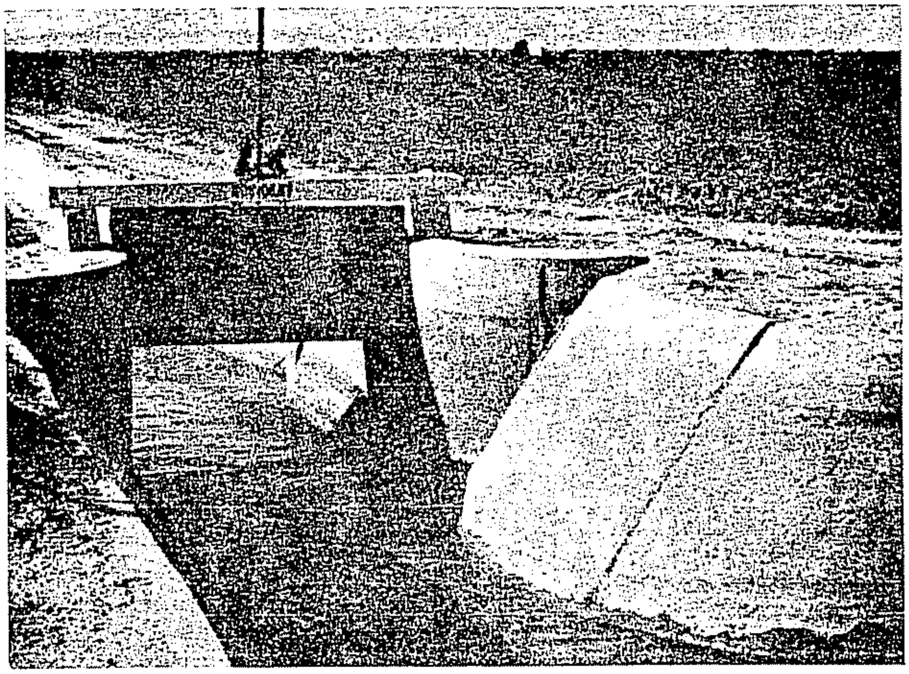
West of the New River the agricultural area is serviced by the Westside Main Canal. It has a capacity of 1,300 cfs and has no concrete lining throughout its 45.4-mile length. Commencing at the terminus of the All-American Canal, the Westside Main Canal heads to a point approximately six miles west of Westmorland to the head of the Trifolium Extension Canal. At the south end of the system the land is generally flat necessitating the placement of laterals above the natural surface. Grade slopes in the northern part of the area increase. Approximately 95,000 acres are served by the Westside Main Canal.

In the south central portion of the Valley, water is delivered by the New Briar Canal. With a capacity of 320 cfs and a total length of 5.3 miles, it serves 48,000 acres. This area is relatively flat and also requires laterals be constructed above the natural surface grade for adequate delivery head.

Two areas at the south end of the Valley receive water directly from the All-American Canal. At the west end, 28,500 acres are served by the Woodbine, Wistaria and Wormwood Canals; and at the east end, 28,500 acres are served by the Holt, Hemlock and South Alamo Canals and Mesa Laterals. Both areas have relatively flat slopes requiring the construction of laterals above the natural surface.

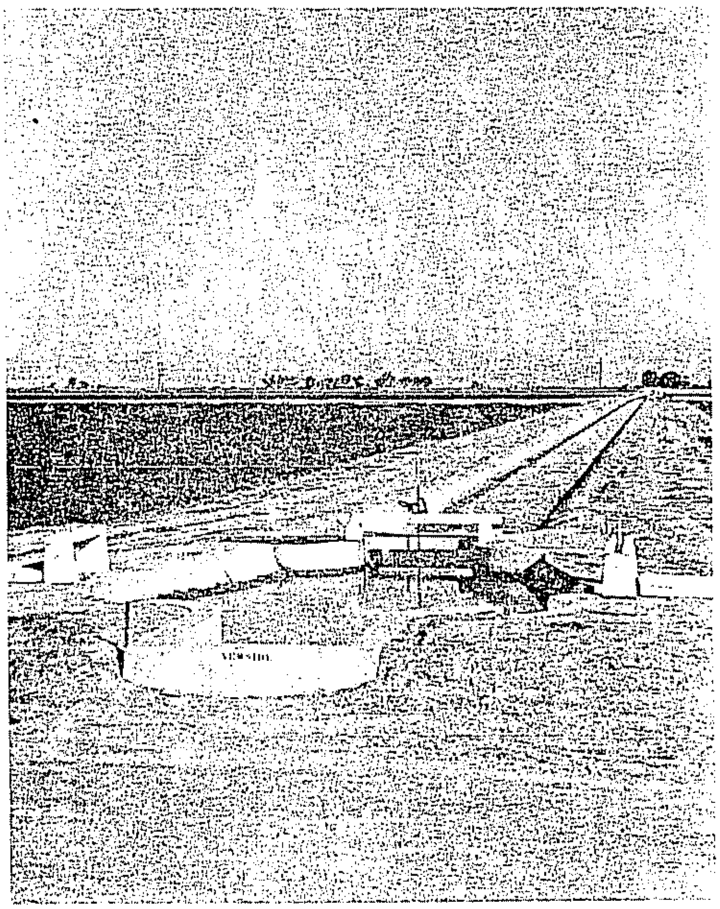
The District also operates four regulating reservoirs located at key points along the main canals. Singh Reservoir regulates the East Highline Canal and is located 1.5 miles south and nine miles east of Calipatria at the Vail Supply Heading. Oscar Fudge Reservoir is located approximately 1.5 miles southwest of the terminal end of the Central Main Canal and Rockwood Heading. Herman "Red" Sperber Reservoir is located at the end of the Rositas Supply Canal. To the west, the J. Melvin Sheldon Reservoir has been built at approximately the midpoint of the Westside Main Canal. Specific data are presented in Table III.2.

Other control structures owned by the District essential to the system are listed in Tables 3, 4 and 5.



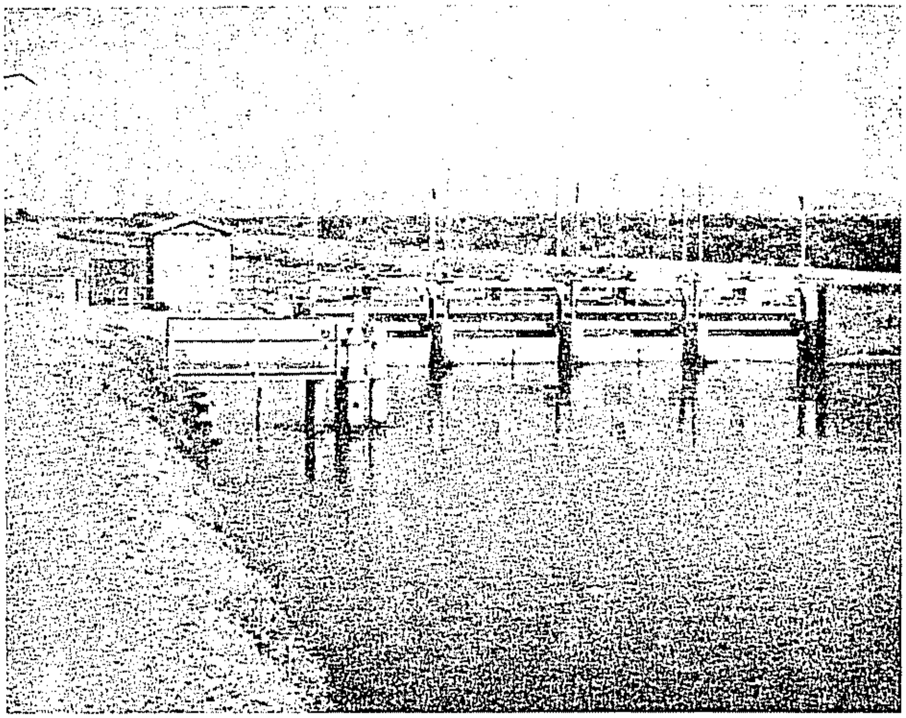
95 PERCENT OF THE 3,411 CHECKS IN THE DISTRICT ARE CONCRETE STRUCTURES.

EXHIBIT III.2



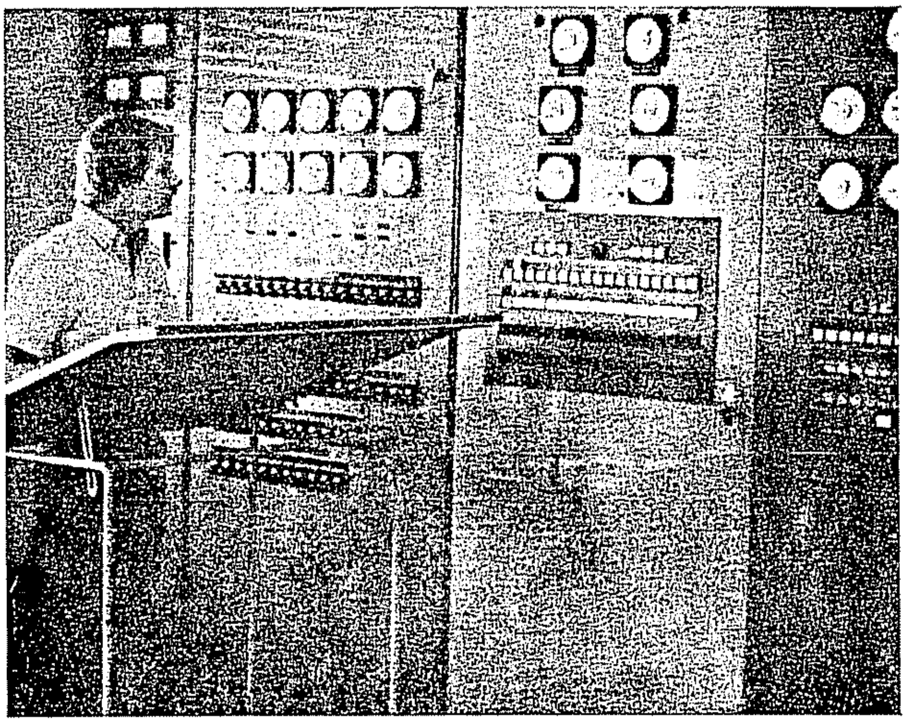
56 PERCENT OF THE DISTRICT'S LATERALS ARE CONCRETE LINED.

EXHIBIT III.3



TWENTY-TWO STRUCTURES ARE REMOTELY CONTROLLED FROM DISTRICT HEADQUARTERS IN IMPERIAL.

EXHIBIT III.4



THE TELEMETERING PANEL IN IMPERIAL IS MANNED 24 HOURS A DAY.

EXHIBIT III.5

TABLE III.2

ITEM	RESERVOIR			
	Singh	Sheldon	Fudge	Sperber
Date of completion	01-20-76	03-29-77	02-26-82	05-01-83
Capacity, acre-feet	323	476	300	470
Area, acres	32	50	37.5	64.6
Maximum depth, ft.	11	10	10	9
Inlet/Outlet flow capacity, cfs	100	100	100	100 Inlet 2 @ 100 Outlet
Inlet control	Automatic Hydraulic	Automatic Hydraulic	Automatic Hydraulic	Automatic Hydraulic
Outlet control	Remote Control	Remote Control	Remote Control	Remote Control
Cost, $1,000	482.5	598.8	1,140.4	1,115.3

b. Drainage System

As part of the operating system, the District maintains an extensive drainage system. Surface drains are used to collect excess surface flows from the fields (tailwater), tile drain discharges and spills from the canals and laterals. Please refer to Exhibit III.6, the drainage system map and Table III.6

There are over 1,453 miles of surface drains that can be divided into three main areas: Alamo River System, New River System, and drains that flow directly into the Salton Sea as shown in Exhibit III.7.

Both the Alamo and New Rivers are maintained by the District,8and through the years control structures have been installed to prevent erosion. Refer to Table III.7 for a listing of these structures.

The lateral drain system is laid out to provide a drainage outlet for each 160-acre plot, and as such the drains usually parallel the canals. At each outlet the District is obligated to provide sufficient depth to accept tile drain discharge. Tile drains are located in the fields buried at a depth of six to ten feet. The tile drains are used to draw off the excess water derived from percolated surface flows in order to prevent the water table from encroaching into the root zone.

Where the drain cannot be maintained at sufficient depth, a sump and pump and provided and maintained by the District.

Erosion in the steeper drains is controlled by the installation of control structures.

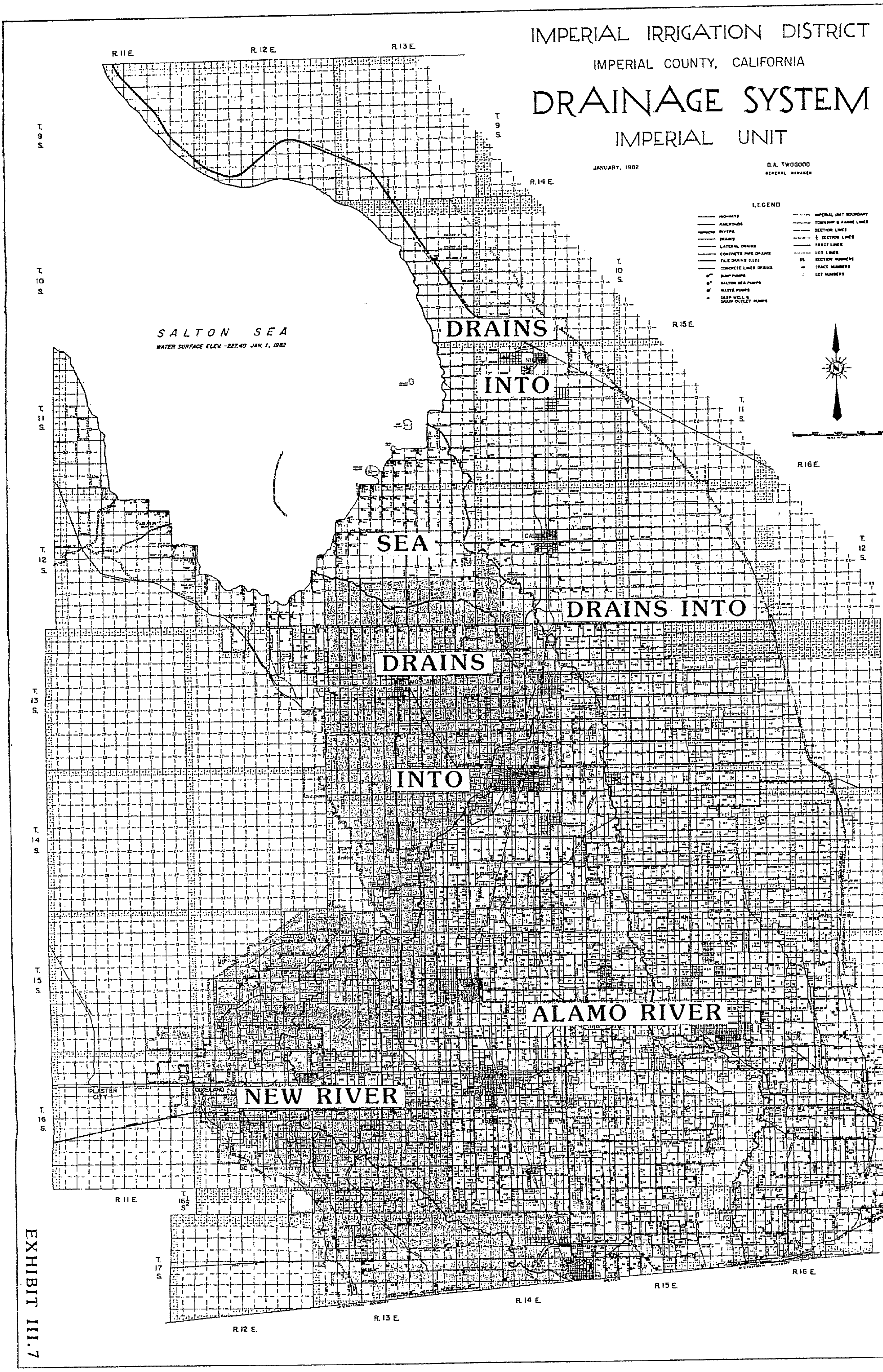


EXHIBIT III.7

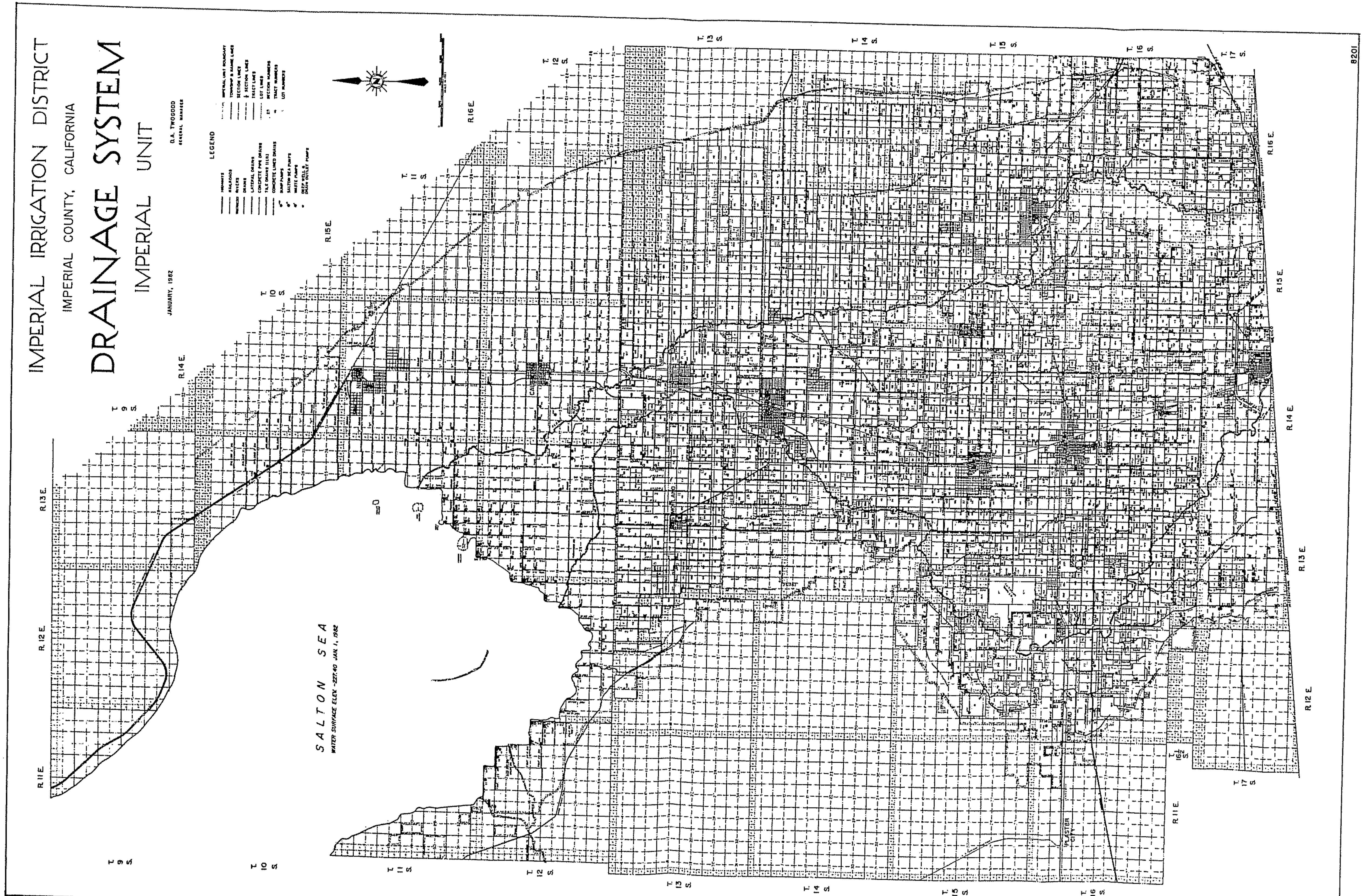


Exhibit III. 6

Table III.3

CANAL AND DRAIN MILEAGE AS OF DECEMBER 31, 1983

	Total Miles	Miles Earth Section	Miles Concrete Lined	Miles Pipelined
All-American Canal - Canals	82.17	79.57	2.60	0.00
All-American Canal - Drains	51.64	37.51	0.00	14.13
Main Canals	153.46	144.52	8.94	0.00
Lateral Canals	1 467.73	642.04	816.90	8.79
Drains	1 399.26	1 299.72	0.40	99.14
Totals	3 154.26	2 203.36	828.84	122.06

Table III.4

LATERAL CANAL MILEAGE AS OF DECEMBER 31, 1983

BY DIVISIONS

Divisions	Total Miles	Miles Earth Section	% Earth Section	Miles Concrete Lined	% Concrete Lined	Miles Pipelined	% Pipelined
Holtville	295.05	73.94	25.06	220.75	74.82	0.36	0.12
El Centro-Calexico	228.11	112.81	49.45	114.80	50.33	0.50	0.22
Imperial	200.76	72.61	36.17	127.11	63.31	1.04	0.52
Brawley	244.01	120.07	49.20	118.00	48.36	5.94	2.44
Westmorland	198.58	61.51	30.97	137.07	69.03	0.00	0.00
Calipatria	301.22	201.10	66.76	99.17	32.92	0.95	0.32
Totals	1 467.73	642.04	43.74	816.90	55.66	8.79	0.60

Table III.5

INVENTORY OF STRUCTURES

December 31, 1983

Main Canals - Divisions	Concrete	Rubble	Wood	Others	Total
Deliveries	191	13	2	-	206
Checks	57	2	-	-	59
Lateral Headings	133	8	-	-	141
Control Structures	97	4	1	-	102
Bridges	5		22	4	31
Siphons	24	1	-	-	25
Moss Pipes	5	-	-	2	7
Storm Spillways	4	4	-	-	8
Flumes	-		-	1	1
Total Divisions	516	32	25	7	580
All-American	145				145
Total Main Canals	661	32	25	7	725
Lateral Canals - Divisions					
Deliveries	5 227	127	26	-	5 380
Checks	3 169	163	19	-	3 351
Lateral Headings	327	24	1	-	352
Control Structures	694	48	19	2	763
Bridges	28	4	28	1	61
Siphons	125	2	-	4	131
Moss Pipes	118	-	4	1	123
Flumes	1	-	-	-	1
Storm Spillways	32	4	-	-	36
Total Lateral Canals	9 721	372	97	8	10 198
Drains					
Control Structures	409	9	12	2	432
Bridges	2		33		35
Siphons	1 304	11	5	39	1 359
Fluaes	3	-	35	1	39
Outlets	214	-	-	-	214
Spillways	21	-	-	-	21
Maintenance Crossings	350	-	-	-	350
Deliveries - Pump	2	-	-	-	2
Deliveries	4	-	-	-	4
Checks	1	-	-	-	1
Total Drains	2 310	20	85	42	2 457

Table III.6

DRAIN MILEAGE AS OF DECEMBER 31, 1983
BY DIVISIONS

Divisions	Total Miles	Miles Earth Section	% Earth Section	Miles Concrete Lined	% Concrete Lined	Miles Pipelined	% Pipelined
Holtville	117.33	98.15	83.65	0.40	0.35	18.78	16.00
El Centro-Calexico	79.83	73.07	91.53	0.00	0.00	6.76	8.47
Imperial	70.36	65.12	92.55	0.00	0.00	5.24	7.45
Brawley	219.27	216.49	98.73	0.00	0.00	2.78	1.27
Westmorland	135.45	133.15	98.30	0.00	0.00	2.30	1.70
Calipatria	281.02	261.06	92.90	0.00	0.00	19.96	7.10
Division Totals	903.26	847.04	93.78	0.40	0.04	55.82	6.18
Drainage	496.00	452.68	91.27	0.00	0.00	43.32	8.73
All-American	51.64	37.51	72.64	0.00	0.00	14.13	27.36
Grand Total	1 450.90	1 337.23	92.16	0.40	0.03	113.27	7.81

Table III.7

LOCATION OF CONTROL DROPS IN ALAMO RIVER

Alamo River Drop No. 2, near center N.E. 1/4 Section 12, 12-14, was installed in 1959.

Alamo River Drop No. 3, northwest corner Section 29, 12-14, was installed in 1960.

Alamo River Drop No. 3-A is located immediately east of the existing North End Dam, northwest corner Section 29, 12-14, was installed in 1967.

Alamo River Drop No. 4 is located immediately west of railroad bridge, near east line Tract 170, Section 3, 13-14, and was installed in 1966.

Alamo River Drop No. 5, northwest corner Tract 180, Section 12, 13-14, was installed in 1960.

Alamo River Drop No. 6, southwest corner Section 30, 13-15, was installed in 1961.

Alamo River Drop No. 6-A, southeast corner Tract 155, Section 18, 14-15, was installed in 1974.

Alamo River Drop No. 7, near center Tract 55, Section 30, 14-15, was installed in 1958.

Alamo River Drop No. 8, center E. 1/2, S.W. 1/4, Section 5, 15-15, was installed in 1958.

Alamo River Drop No. 9, S.E. 1/4, N.E. 1/4 Section 20, 15-15, was installed in 1958.

Alamo River Drop No. 10, west line Lot 20, Section 21, 15-15, was installed in 1958.

Alamo River Drop No. 12, Tract 72, Section 26, 15-15, was installed in 1967.

Alamo River Drop No. 13, southwest corner Tract 65, Section 36, 15-15, was installed in 1967.

LOCATION OF CONTROL DROPS IN NEW RIVER

New River Drop No. 2, center Tract 139, Section 9, 13-14, was installed in 1973.

New River Drop No. 3, northwest corner Tract 92, Section 21, 13-14, was installed in 1964.

New River Drop No. 4, near west line Lot 4, Section 32, 13-14, was installed in 1965.

2. Operations

a. Water Operations

The Water Control Section of the Water Department is responsible for the transmission of water through the main canal system and its diversion to the laterals for distribution to the users. Water dispatching through the main canal system is accomplished by remote and local control coordinated by the dispatching unit of Water Control on a 24-hour basis. These operations are carried out from the Water Control Office located at the Imperial Irrigation District Headquarters in Imperial.

Scheduling District water on a long-term basis is a complicated task. Each December an estimate of the amount of water the District will need for the following calendar year is given to the USBR. Then each week during the year an order for weekly requirements is submitted. On Wednesday of each week an order for the following week, Monday through Sunday, is phoned to the District's River Division and later verified by letter. The USBR accumulates the orders from all water users of the Lower Colorado River and prepares a Master Schedule of flows for the Colorado River. The amount of water scheduled on the Master Schedule is the quantity of water the District will receive unless it is revised by the Watermaster at least 72 hours in advance.

The origin of the water demand utimately is the user. Water orders from the water users are accumulated by the six operating divisions within the District. These are located in Holtville, El Centro, Imperial, Brawley, Westmorland and Calipatria, as shown on Exhibit III.8. Orders for next-day delivery very are accepted until 12:00 noon. Soon thereafter they are relayed to the Water Control Section, stating the amount of heads lined up to run and the number carried over. "Carry overs" are orders left undelivered because of insufficient water allotment the day before by the Water Control Dispatcher. By 1:00 p.m. the Water Control Office allots all available water back to the six divisions in the amount necessary to keep their carryover percentages nearly equal. In addition, by 1:00 p.m. a firm order is placed with the River Division for the following day, and changes in the Master Schedule for the fourth day following are made. Using the total amount allotted, the six divisions call in the order for each lateral heading to the Water Control Section. The dispatcher at the Water Control office then prepares a water plan for the following day, scheduling changes throughout the main canal system in order to have the correct amount of water at the right place and time the following morning. These changes are given to the Water Control operator to execute. Water is transported through the main canal system by remote control from a panel located in the Water Control office with, the help of night patrolmen in radio-equipped vehicles. The following morning, under the direction of the Operations Unit of the Water Control Section, the hydrographer turns and measures this water into the head of the laterals. Approximately 75 percent of this water is measured by the head pressure method with the remainder being measured with a current meter or a pre-rated gate.

The division water clerks log each order for the following day by lateral and individual zanjero run. Highest priority for service goes to those orders already running, then orders carried over from the previous day, and finally the current water orders based on time received. Total orders are determined and compared with the amount estimated by Water Control. The division water clerk then calls Water Control to verify the estimated order or request a change. Water Control, after analyzing similar data from all the divisions and taking into consideration the current capabilities of the system, notifies each division of its revised allotment.

The division then allocates the revised allotment among the various canals. Division water clerks then make any final adjustments to individual deliveries for the following day.

The water distribution system within each division is divided into runs. This refers to a specific area containing a portion of main canal, a set of laterals, and customer turnouts assigned to each zanjero.

The zanjeros, under the direction of the six divisions, divert the water through the lateral canal system, open the water users headgate and measure the water in the proper amounts. Flow rate is determined by setting the gate opening in relation to the difference in water elevation upstream and downstream of the gate. Rating curves have been developed so the zanjero can set the proper gate opening to deliver the ordered head. The following day the amount of water delivered to a water user for the past 24 hours is given to the Accounting Department for billing.

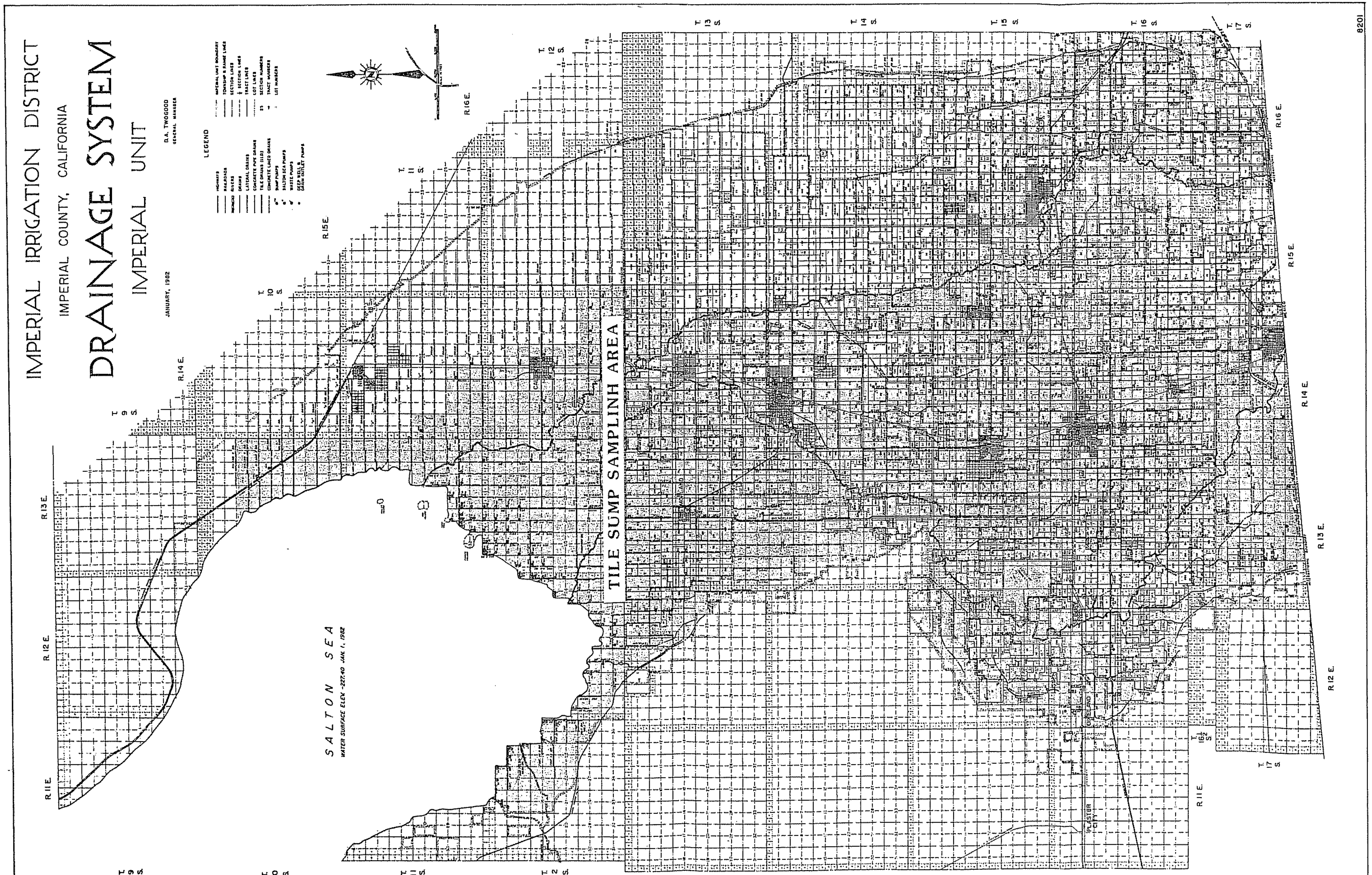

IMPERIAL IRRIGATION DISTRICT
IMPERIAL COUNTY, CALIFORNIA
DRAINAGE SYSTEM
IMPERIAL UNIT
JANUARY, 1962
D.A. TWOGOOD
GENERAL MANAGER
LEGEND
TILE SUMP SAMPLINH AREA
SALTON SEA
WATER SURFACE ELEV. -227.40 JAN. 1, 1962
R.11 E.
R.12 E.
R.13 E.
R.14 E.
R.15 E.
R.16 E.
8201

Exhibit VI.4

Water releases from Hoover Dam require approximately six days of travel time before they arrive at the users-headgate. The physical path followed by a hypothetical water order can be appreciated by examining Exhibit III.9.

The hydrographers and zanjeros also have the duty of checking the tailwater structure of each delivery. In this way, the assessment phase of the District's Water Conservation Program is put into operation. The physical integrity of the irrigation system is preserved by maintenance crews assigned to each division.

b. Drainage Operations

In the preceding Drainage System Section above, a description of the District's extensive drainage system is given. Herein is presented an overview of the operational work performed by the District. The intent of the drainage system is to provide a drainage outlet for each nominal 160-acre parcel of land serviced by the District. The District's Rules and Regulations governing the construction, operation and maintenance of its drainage system clearly delineate the various items of drainage operations.

Maintenance of the many open-channel drains, pipeline drains, and sump-pump systems is a task that requires a major commitment of labor and equipment each year. Major items of work include removal of silt deposits, weed control and removal, repair and replacement of drainage structures and sump pumps, and grading of drainage canal banks.

Although the drainage system is essentially complete, a small percentage of the 160-acre irrigated parcels has not been provided with direct drainage outlets. New construction is used when it is desired to connect these areas to the drainage system. Reconstruction is also necessary to accommodate changes such as revisions to the County Road System and construction activities associated with the building of geothermal power plants.

In addition to having maintenance and construction responsibilities, the District has responsibility for the design of structures to be placed or replaced in the District's drain system. Primary considerations in the design include hydraulic capacities and flow characteristics, resistance to structural loading, and erosion control. Close communication with the water users and with the appropriate public agencies is essential.

Other drainage work performed by the District includes logging of soil profiles, seepage studies, drainage flow source investigations, design of tile drain systems, inspection of drainage construction work performed by private contractors, and the monitoring of activities of water users to check for compliance with the District's Rules and Regulations. Extensive records are kept related to all facets of the drainage system.

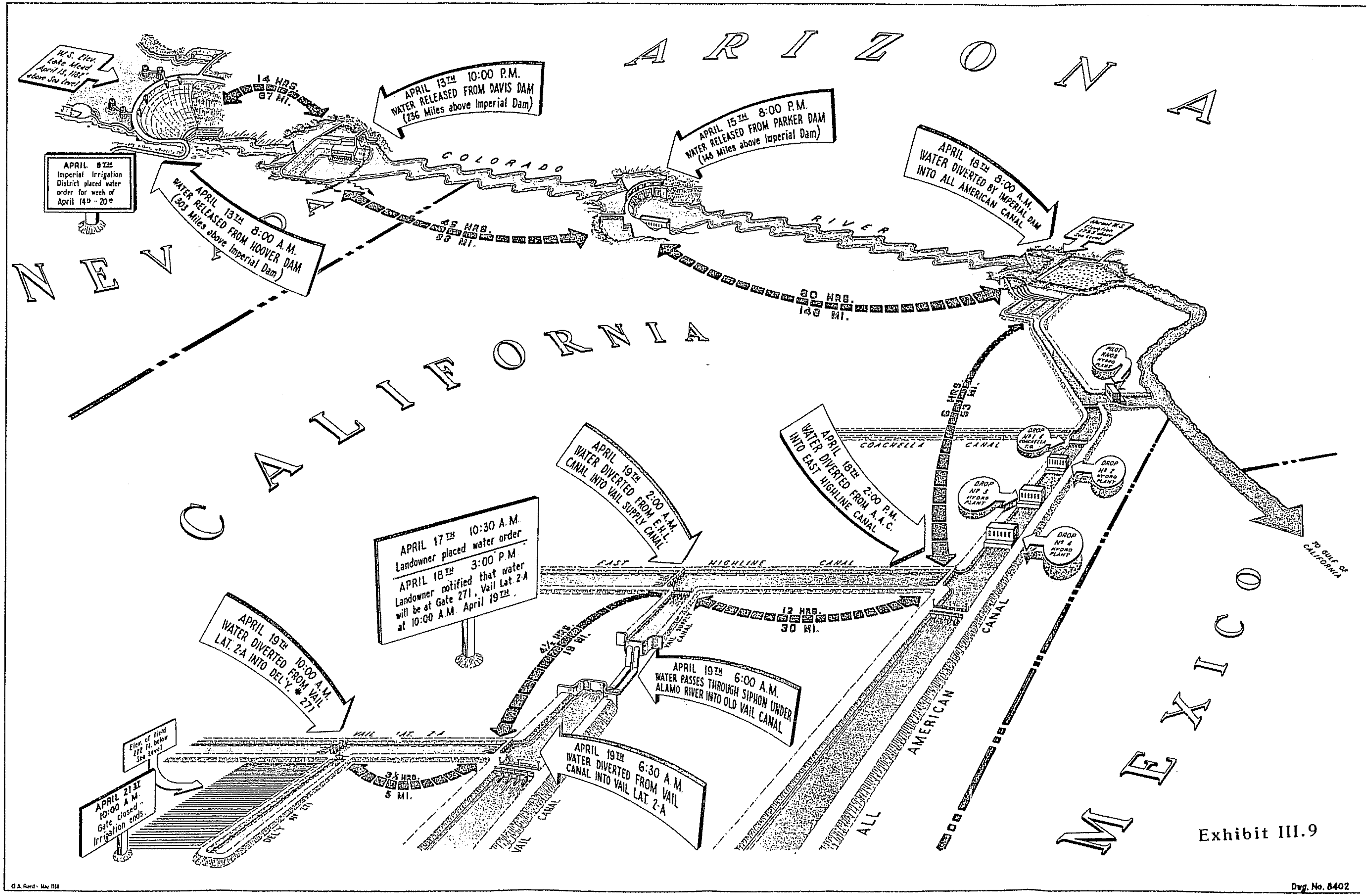
C. AGRICULTURAL USES

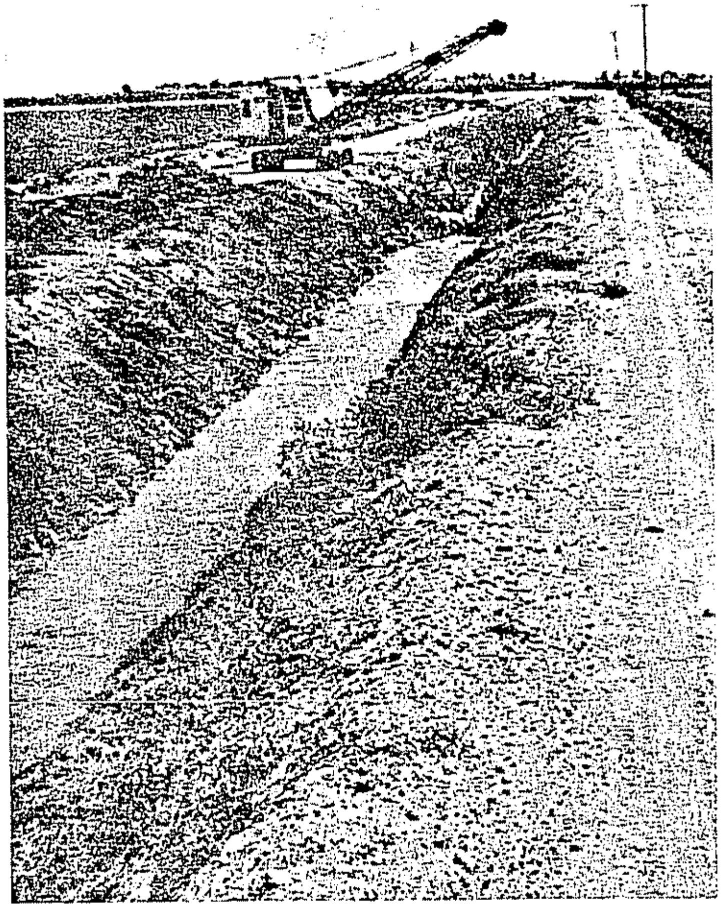
The Imperial Valley's enormous capacity to produce a wide variety of crops in a previously barren desert environment is made possible by the

IMPERIAL IRRIGATION DISTRICT

WATER TRANSPORTATION

HOOVER DAM TO USER





A DISTRICT DRAIN BEING CLEANED.

EXHIBIT III.10

HYDRILLA WAS FIRST DISCOVERED IN THE DISTRICT'S SYSTEM IN 1977. A TEAM OF BIOLOGICAL SCIENTISTS WAS HIRED TO COMBAT THIS AQUATIC WEED, WHICH THREATENS TO CHOKE OFF THE FLOW OF WATER IN IT'S CANALS.

EXHIBIT III.11

application of modern farming techniques. All phases of farming, including land preparation, fertilizing, seeding, irrigating, cultivating, etc., are designed to overcome the harsh desert conditions that are natural to the area. Extreme temperatures, soil salinity, low humidity, relatively marginal farming soils, etc., are but a few of the obstacles continually overcome by the local farmer. Most of these can be alleviated by an adequate supply of water.

Over 120 types of crops are grown locally. Refer to Table III.8 for a breakdown of the acreages planted to each major crop in 1983. It must be noted that the cropping pattern in the Imperial Valley is dynamic, reflecting socioeconomic pressures, government programs, and developments in agricultural technology.

1. Water Quality - Leaching Requirements

Being at the "end of the River," the District and other water users diverting at or below Imperial Dam receive water that contains a large percentage of return flow, i.e., water that was diverted upstream and conveyed through channels and canals. Much of it is applied to land or run through municipal and industrial facilities, and the nonconsumed portion is returned, picking up salts, minerals, and other matter in the process. The Colorado River itself picks up elements from the soil through which it and its tributaries flow.

The salinity of Colorado River water has been gradually increasing during the past several decades. During the past few seasons, large

IMPERIAL IRRIGATION DISTRICT
ANNUAL INVENTORY OF AREAS RECEIVING WATER
YEARS 1983, 1982, 1981

I CROP SURVEY

GARDEN CROPS	ACRES 1983	1982	1981
Beans	79	165	20
Blackeyed Peas	85	0	0
Broccoli	4 427	2 306	2 466
Broccoli (Seed)	258	40	35
Cabbage	31	444	510
Cabbage, Chinese	32	22	3
Cabbage (Seed)	37	198	25
Carrots	7 402	8 917	6 605
Carrots (Seed)	104	218	0
Cauliflower	151	84	179
Cauliflower (Seed)	27	20	60
Celery	161	533	551
Chicory	0	6	3
Collards	0	25	53
Cucumbers	137	155	173
Dill	0	0	36
Ear Corn	510	658	2
Eggplant	18	2	4
Endive (Seed)	18	18	0
Fava Beans	27	54	20
Fennel	3	3	0
Flowers	187	229	111
Flowers (Seed)	79	0	0
Garlic	376	306	159
Herbs, Mixed	55	52	9
Herbs (Seed)	67	26	157
Lettuce	26 086	31 086	36 997
Lettuce, Butter	0	0	35
Lettuce, Chinese	0	0	30
Lettuce, Red	0	0	35
Lettuce, Romaine	0	0	143
Lettuce (Seed)	382	77	2
Melons			
Cantaloupes, Fall	5 319	6 547	7 680
Cantaloupes (Seed)	141	44	75
Cantaloupes, Spring	7 944	7 473	6 877
Casaba, Fall	18	41	215
Casaba, Spring	170	0	0
Crenshaw, Fall	366	873	513
Crenshaw, Spring	49	50	39
Honeydew, Fall	1 046	2 547	1 648
Honeydew, Spring	388	370	156
Kava Melons	21	10	0
Mixed, Fall	860	662	225
Mixed, Spring	270	135	8
Watermelons	4 972	5 354	3 917
Watermelons (Seed)	200	25	70
Mung Beans	0	33	105
Mustard	38	148	179
Mustard (Seed)	60	209	70
Okra	96	188	14
Okra (Seed)	96	466	194
Onions	7 248	10 013	5 739
Onions (Seed)	2 886	2 371	3 232
Parsley	72	20	0
Parsley (Seed)	0	79	0
Parsnips	0	20	0
Peas	0	15	1
Peas (Seed)	137	54	0
Peppers, Hot	0	8	46
Peppers, Sweet	120	12	35
Radishes	11	149	48
Radishes (Seed)	167	28	0
Rappini	184	156	305
Rhubarb	0	0	40
Rutabagas	36	40	21
Sesame (Seed)	15	2	0
Spinach	16	0	30
Squash	797	1 286	1 471
Squash (Seed)	0	34	0
Swiss Chard	0	1	20
Swiss Chard (Seed)	0	30	0
Tomatoes, Fall	0	18	66[illegible]
Tomatoes, Spring	2 822	3 053	2 76[illegible]
Turnips	105	205	150
Vegetables, Mixed	402	4	121
Vegetables, Mixed (Seed)	0	35	37
Waterlilies	16	17	1[illegible]
Total	77 827	88 459	85 15[illegible]

FIELD CROPS	ACRES 1983	1982	1981
Alfalfa	205 138	202 190	171 810
Alfalfa (Seed)	2 685	833	2 51[illegible]
Alicia Grass	50	52	62
Barley	259	232	382
Bermuda Grass	2 816	3 684	3 745
Bermuda Grass (Seed)	16 428	7 849	5 929
Clover	150	20	20
Clover (Seed)	0	349	0
Cotton	18 079	42 217	80 001
Dichondra Grass	20	38	38
Field Corn	294	0	0
Grass, Mixed	30	276	204
Oats	274	717	39
Rape	267	0	0
Rye Grass	2 540	4 892	2 332
Rye Grass (Seed)	185	188	0
Safflower	0	0	109
Sali Cornia	10	0	0
Sesbania	75	0	0
Sesbania (Seed)	0	38	0
Sorghum Grain	1 616	2 335	2 300
Sorghum Silage	552	582	775
Soy Beans	0	181	145
Spirulina Algae	12	0	0
Sudan Grass	10 410	8 013	22 122
Sudan Grass (Seed)	228	0	0
Sugar Beets	39 525	37 607	43 921
Triticale Grain	0	58	55
Wheat	99 507	175 047	164 097
Total	401 150	487 398	500 601

PERMANENT CROPS	ACRES 1983	1982	1981
Asparagus	2 992	2 459	2 568
Citrus			
Grapefruit	464	444	294
Lemons	710	671	776
Mixed	390	191	191
Oranges	356	353	369
Tangerines	113	75	75
Dates	132	53	53
Duck Ponds (Feed)	12 908	8 169	8 064
Fish Farms	1 196	754	684
Fruit, Mixed	21	21	16
Grapes	30	0	0
Guar Beans	0	1 892	299
Jojoba	3 005	3 062	508
Nursery	0	5	5
Palms	13	11	9
Pasture, Permanent	449	386	312
Peaches	40	24	24
Pecans	40	32	32
Total	22 859	18 602	14 279
Total Acres of Crops	501 836	594 469	600 035

Note: Crops are listed for the year in which they are predominately harvested.

SUMMARY

		1983		1982		1981
Number of Farm Accounts		6 997		6 933		7 005
Number of Owner-Operated Farm Accounts	(32.0%)	2 225	(30.5%)	2 119	(32.1%)	2 250
Number of Tenant-Operated Farm Accounts	(68.0%)	4 772	(69.5%)	4 814	(67.9%)	4 755
Average Acreage of Farm Accounts		73.67		70.83		70.41

II SUMMARY OF AREA SERVED

	ACRES 1983	ACRES 1982	ACRES 1981
Field Crops	401 150	487 398	500 601
Garden Crops	77 827	88 469	85 155
Permanent Crops	22 859	18 602	14 279
Total Acres of Crops	501 836	594 469	600 035
Total Duplicate Crops	61 089	133 113	136 948
Total Net Acres in Crops	440 747	461 356	463 087
Area Being Reclaimed: Leached	5 178	3 959	1 112
Net Area Irrigated	445 925	465 315	464 199
Area Farmable but not Farmed during Year (Fallow Land)	52 592	16 618	15 108
Total Area Farmable	498 517	481 933	479 307
Area of Farms in Homes, Feed Lots, Corrals, Cotton Gins, Experimental Farms, and Industrial Areas	13 646	13 903	13 905
Areas in Cities, Towns, Airports, Cemeteries, Fairgrounds, Golf Courses, Recreational Parks, Lakes, and Rural Schools, Less Area Being Farmed	16 047	14 508	14 113
Total Area Receiving Water	528 210	510 344	507 325
Area in Drains, Canals, Rivers, Railroads, and Roads	74 018	73 513	73 161
Area below -230 Salton Sea Reserve Boundary and Area Covered by Salton Sea, Less Area Receiving Water	39 481	39 417	39 417
Area in Imperial Unit not Entitled to Water	63 933	63 933	63 933
Undeveloped Area of Imperial, West Mesa, East Mesa, and Pilot Knob Units	269 619	288 054	291 425
Total Acreage Included - All Units	975 261	975 261	975 261
*Acreage Not Included - All Units	87 029	87 029	87 029
Total Gross Acreage within District Boundaries	1 062 290	1 062 290	1 062 290

IMPERIAL IRRIGATION DISTRICT

R Wilson

J. R. WILSON, Manager
Water Department

*Acreage within District Boundaries that is not Included in District.

flood-protection releases from storage have diluted the Colorado River, and salinity has been lower as a result - ranging from 700 to 800 parts per million (ppm) in 1983 and 1984 at Imperial Dam. Sediment (silt) in the water supply is shown in Table III.9.

The District has maintained water salinity records of the All-American Canal below Drop No. 1 for many years. The average "t.a.f." (tons per acre-foot) of dissolved salts in the District's water supply (one t.a.f. is equivalent to 735 ppm) is shown in Table III.10.

A record of salinity of water supply (Drop No. 1) and drainage discharge waters, including a summary of salt balance, is shown in Table III.11.

Salinity in water is important to understand, because at high concentrations it can prevent plant growth, corrode iron and even brass plumbing, and concentrate in the soil.

The effect of constituents in the water supply is also of significance. The constituents of a water sample from the All-American Canal below Drop No. 1 are given in Exhibit III.12. Each of these constituents can affect crop growth or adversely modify the soil structure, but no effort will be made here to discuss these impacts. This information is included because water quality is as important as water quantity, and is directly related to leaching requirements, drainage and, of course, the types of crops which can be grown economically.

Table III.9

TONS OF SEDIMENT REMOVED BY DESILTING BASINS AT IMPERIAL DAM

Year	Sediment	High Month	Total Tons	Low Month	Total Tons
1961	196 553	July	58 635	December	144
1962	337 927	July	81 120	December	338
1963	515 033	July	100 802	December	551
1964	392 573	July	120 565	December	331
1965	433 468	August	143 109	January	439
1966	542 921	July	180 225	January	455
1967	318 777	August	92 033	December	259
1968	459 410	March	130 290	December	481
1969	467 052	April	98 337	December	264
1970	445 798	April	180 957	November	858
1971	441 146	April	122 157	January	1 088
1972	439 086	April	138 713	December	1 351
1973	481 774	April	181 326	February	1 169
1974	626 447	April	201 486	January	1 103
1975	470 161	April	132 456	November	994
1976	556 506	April	199 599	January	1 276
1977	530 026	July	150 466	December	1 651
1978	522 696	July	154 504	January	461
1979	646 766	July	201 383	January	176
1980	3 535 757*	July	1 331 953*	January	1 436
1981	455 671	August	145 520	October	75
1982	39 475	April	100 176	December	75
**1983	1 104 265*	May	389 891	March	1 406

*Caused by extreme high river release

**July-Dec. - Due to high water in Colorado River, the sediment pipes were submerged and no samples were taken.

Table III.10

SALINITY OF WATER BELOW DROP 1 ON ALL-AMERICAN CANAL

Year	*Aver. t.a.f.	Total Tons (Millions)	Year	*Aver. t.a.f.	Total Tons (Millions)
1954	1.01	3.1	1969	1.27	3.4
1955	1.17	3.4	1970	1.27	3.5
1956	1.27	3.7	1971	1.27	3.7
1957	1.22	3.4	1972	1.24	3.5
1958	1.00	2.7	1973	1.18	3.5
1959	1.00	2.9	1974	1.19	3.7
1960	1.06	3.2	1975	1.19	3.6
1961	1.13	3.3	1976	1.17	3.3
1962	1.15	3.4	1977	1.13	3.0
1963	1.13	3.4	1978	1.08	2.9
1964	1.19	3.3	1979	1.15	3.2
1965	1.30	3.4	1980	1.10	3.1
1966	1.30	3.7	1981	1.15	3.2
1967	1.22	3.3	1982	1.16	2.9
1968	1.21	3.4	1983	1.05	2.5

*Weighted Average, Salt Concentrations

Table III.11

SUMMARY OF SALT BALANCE
EXCLUDING WATER AND SALT FROM MEXICO

Year	INFLUENT 1/ Total Discharge AF	INFLUENT 1/ Tons of Salt Brought Into the Area	INFLUENT 1/ Weighted Average 2/ T.A.F.	INFLUENT 1/ Weighted Average 2/ p.p.m.	EFFLUENT Total Discharge AF	EFFLUENT Tons of Salt Removed	EFFLUENT Weighted Average 2/ T.A.F.	EFFLUENT Weighted Average 2/ p.p.m.	Tons Salt Diff.	Percent Loss or Gain
1958	2 730 876	2 723 153	1.00	735	974 045	3 341 376	3.43	2 52	618 223	22.70 gain
1959	2 840 173	2 852 019	1.00	735	1 020 963	3 401 652	3.33	2 44	549 633	19.27 gain
1960	2 983 860	3 162 485	1.06	779	1 059 804	3 558 534	3.36	2 47	396 049	12.52 gain
1961	2 957 200	3 330 087	1.13	831	1 050 700	3 572 808	3.40	2 49	242 721	7.29 gain
1962	2 951 266	3 399 464	1.15	845	1 088 965	3 806 946	3.50	2 57	407 482	11.99 gain
1963	2 991 429	3 378 583	1.13	831	1 153 827	4 050 087	3.51	2 58	671 504	19.88 gain
1964	2 770 474	3 284 284	1.19	875	905 153	3 635 121	4.02	2 95	350 837	10.68 gain
1965	2 624 363	3 406 457	1.30	955	882 962	3 819 255	4.33	3 18	412 798	12.12 gain
1966	2 817 912	3 650 447	1.30	955	1 004 685	4 148 874	4.13	3 03	498 427	13.65 gain
1967	2 719 861	3 306 261	1.22	897	1 027 970	4 139 477	4.03	2 96	833 216	25.20 gain
1968	2 806 124	3 408 548	1.21	889	1 001 027	4 012 009	4.01	2 94	603 461	17.70 gain
1969	2 675 833	3 396 105	1.27	933	962 639	3 754 477	3.90	2 86	358 372	10.55 gain
1970	2 754 898	3 488 023	1.27	933	1 020 503	3 780 732	3.70	2 71	292 709	8.39 gain
1971	2 883 969	3 666 277	1.27	933	1 092 571	3 900 990	3.57	2 62	234 713	6.40 gain
1972	2 846 613	3 541 248	1.24	911	1 063 537	3 886 592	3.65	2 68	345 344	9.75 gain
1973*	2 956 013	3 492 199	1.18	867	1 065 414	3 980 338	3.74	2 74	488 139	13.98 gain
1974*	3 072 327	3 669 832	1.19	875	1 123 492	4 204 158	3.74	2 74	534 326	14.56 gain
1975*	3 001 207	3 581 043	1.19	875	1 128 268	4 196 407	3.72	2 73	615 364	17.18 gain
1976*	2 783 630	3 263 454	1.17	860	1 084 993	4 361 658	4.02	2 95	1 098 204	33.68 gain
1977*	2 693 030	3 039 155	1.13	831	1 020 797	4 187 227	4.10	3 01	1 148 072	37.78 gain
1978*	2 671 798	2 897 906	1.08	797	995 674	3 824 323	3.84	2 82	926 417	31.97 gain
1979*	2 803 166	3 216 228	1.15	843	1 056 652	3 998 131	3.78	2 78	781 903	24.31 gain
1980*	2 769 495	3 058 785	1.10	812	1 043 241	3 988 611	3.82	2 81	929 826	30.40 gain
1981*	2 769 112	3 192 402	1.15	847	962 925	3 825 050	3.97	2 92	632 648	19.82 gain
1982*	2 515 637	2 918 781	1.16	853	888 575	3 608 490	4.06	2 98	689 709	23.63 gain
1983*	2 416 885	2 538 349	1.05	772	867 835	3 333 260	3.84	2 82	794 911	31.32 gain

Note: Part of the water in Alamo River from Mexico was used for irrigation in U.S. prior to January 4, 1958.
1/ Based on weekly samples at All-American Canal Station 2963 (East Highline Check) 1958 through 1972
2/ p.p.m. = 735 x T.A.F.
Prior to January. 1, 1970, all salt concentrations were obtained by evaporation and drying at 105° C.
Subsequent to January, 1970, concentrations were obtained by drying at 180°C.

*Based on weekly samples at All-American Canal below Drop 1

IID-442H
(R3 2-70)

LABORATORY CERTIFICATE
IMPERIAL IRRIGATION DISTRICT

Testing Laboratory
Imperial, California

LABORATORY
NO. 100042

Date Sampled November 7, 1984

Sampled By Gawat & Granado

Date Received November 7, 1984

Date Tested November 13, 1984

Description AAC Below Drop #1

Discharge 1645 c.f.s.

Time 9:30 a.m.

Temperature 62°

DETERMINATIONS

Total Dissolved Solids (Dried @ 180° C.) T.A.F. 0.91 p.p.m. 666
K x 10^6 @ 25° C. 1010
pH 8.8

S.A.R. = 1.84

	p.p.m.		e.p.m.	% e.p.m. Cations
Ca	79		3.96	40
Mg	33		2.68	33
Na+K	77		3.36	33
		189		
				% e.p.m. Anions
HCO_3	107		1.76	18
SO_4	237		4.94	49
Cl	117		3.30	33
		461		
		650		
-1/2 HCO_3		53		
		597		

Eng. Files
LAB21

Exhibit III.12

In order to maintain a favorable salt balance, water in excess of the consumptive use requirement must be utilized; this is called the leaching requirement. It is very important because of the magnitude of excess water it creates. Typical values range from 8 to 42 percent of total applied water. These values are predicated on the assumption that the soil profile has been thoroughly reclaimed, i.e., excess salinity has already been leached out. In many areas of the Valley the soil is still being reclaimed, so actual leaching requirements will exceed the theoretical ones based upon salt balance considerations.

Soil salinity is a continuing problem. It has been minimized by the installation of leach lines throughout the Imperial Valley. In order to operate a leaching system properly, adequate amounts of water must be introduced.

2. Consumptive Use

Consumptive use is a term that refers to the amount of water utilized by crops to build up plant tissue, transpired from the plant surface, and evaporated from the soil surface . Consumptive use will vary dramatically for the various crops and varieties, and is affected by soil and climatic conditions and the method of water application.

3. Total Water Use

The actual on-farm use of water may be derived by adding the consumptive use and leaching requirements, and dividing by the on-farm application efficiency. A summary is shown in Table III.12 listing for each of the major crops, ranges and mean values of acreages, consumptive use and leaching requirements as determined by local studies.

4. Agricultural Practices

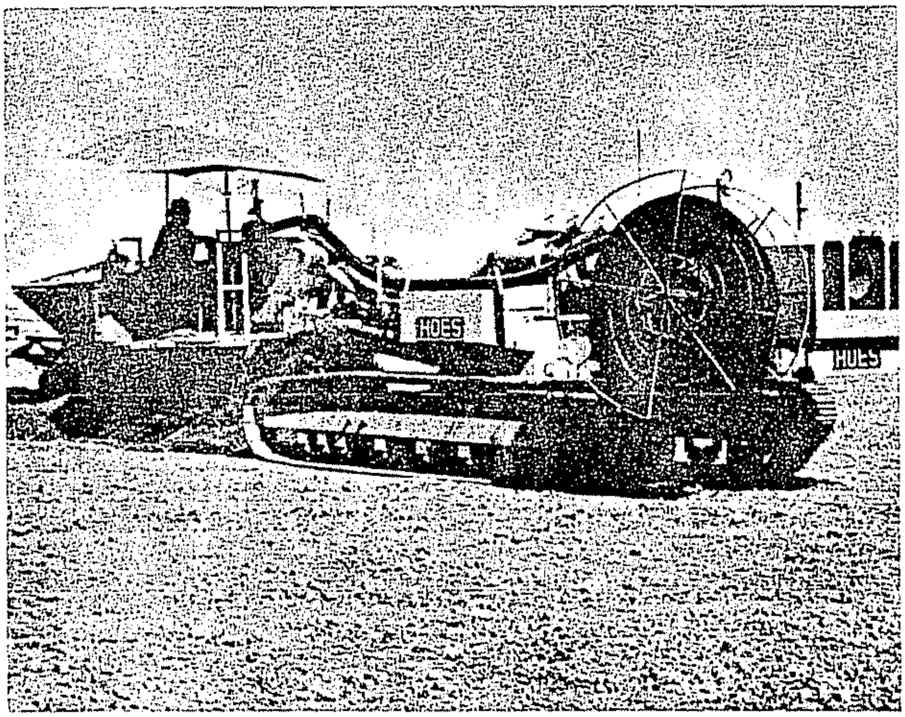
a. Land Preparation

1) Cultural Practices: Cultural practices vary for different crop categories (i.e., grains, vegetables, melons, etc.) as well as with individual growers and various locations within the District boundaries.

A moldboard plow or a "subsoiler" (a vertical shank which is drawn through the soil) is usually then used to promote aeration and water penetration for the following crop.

This operation is necessary due to the contents of clay strata in the soil profile and compaction from various cultivation and harvesting operations of the previous crop.

The next step is usually the use of a disk harrow, with the disk operation done in two steps, the second phase being at an angle opposite to the first. This operation is performed to further incorporate previous crop residues into the soil and to reduce clod size to a more desirable and uniform surface texture.



28,971 MILES OF TILE HAVE BEEN INSTALLED TO LEACH OUT ACCUMULATING SALTS.

TABLE III.12: TOTAL AGRICULTURAL WATER USE

CROP	(1) Acreage, 1974 - 1983 (Acres X 1000)		(2) Consumptive Use (Acre-Feet Per Acre)	(3) Leaching Requirement (Acre-Feet Per Acre)	Total Requirement, Assuming 100% Application Efficiency (Acre-Feet Per Acre)
	Range	Mean			
Alfalfa	158 - 208	181.0	6.0	1.1	7.1
Barley	0 - 7.5	3.5	1.8	0.2	2.0
Cotton	18 - 138	69.5	3.6	0.3	3.9
Sorghum, Grain	1.5 - 31.5	11.5	2.5	0.3	2.8
Sudan	6.5 - 26	16.0	2.5	0.3	2.8
Sugar Beets	36.5 - 74	51.5	3.7	0.3	4.0
Wheat	67.5 - 175	129.0	2.1	0.2	2.3
Misc. Field Crops	8.5 - 23.5	15.5	2.5	0.4	2.9
Melons	11 - 24	16.5	2.3	1.2	3.5
Lettuce	26.5 - 48.5	40.0	1.4	0.5	1.9
Carrots	4.5 - 9	7.0	1.3	0.6	1.9
Tomatoes	1.5 - 6	3.5	2.3	0.4	2.7
Misc. Garden Crops	11 - 21.5	16.0	1.7	0.4	2.1
Citrus	1.5 - 2.5	2.0	3.8	2.6	6.4
Misc. Permanent Crops	11.5 - 21	14.0	4.2	2.9	7.1
TOTAL	0 - 208	38.5	3.7	0.6	4.3

(1) = Rounded to nearest 500 acres.

(2) = Kaddah, M. T. and Rhoades, J. D., 1976, Salt and Water Balance in Imperial Valley, California: Soil Science Society of American Journal, v. 40, No. 1, pages 93-100.

(3) = Based on 10-year average EC of incoming irrigation water of 1.22 mmhos/cm, and the EC of soil saturation extract that will reduce crop yield by not more than 10% from Drainage of Agriculture edited by J. V. Schilfgaarde, p. 73, and U.S.D.A. Bulletin No. 283, pages 10-12.

The next operation usually consists of a minor leveling operation done by a "floating" or "planing" process. This step results in a more uniform surface gradient and furthers the process of reducing clod size, permitting a more even distribution of irrigation water during subsequent cropping.

The next operation usually consists of constructing borders and irrigating by flood method, prior to the planting of a crop. This is done for various reasons which include: germination of weed seeds, decomposition of organic matter in the soil, and to provide a more desirable surface texture for the seed bed.

At this point, fertilizer and/or herbicides may be applied and incorporated into the soil during the following process of disking and planing. If the crop is to be irrigated by the flooding method, borders are then reconstructed and the seed is placed in the soil and irrigated.

If the crop is to be furrow irrigated, rows are then constructed and frequently a mechanical incorporator is used to apply herbicides and prepare the seed bed. The seed is then placed in the soil and either sprinkler or furrow irrigated to germinate the crop.

2) Deep Tillage. Compaction of soil is a common problem in the Valley. Deep tillage must be done frequently to break

up the compacted layers. There are three basic types of deep tillage done in the Valley. They are chiseling, slip plowing and deep plowing.

Chiseling is normally done once each year to break up the compacted top 30 inches of the soil. This procedure is accomplished by pulling three shanks three feet apart through the soil at a depth of 30 inches.

In some soils, it is desirable to restructure the soil stratum by use of a "slip plow" which is designed to bring coarse soil particles up through the finer soil layers to enhance water and root penetration. This operation is usually done not more than twice on any given area to produce the desired effects.

Deep plowing to a depth of five feet is done to mix the fine and coarse soil particles, improving the soil structure and water and root penetration. This operation is only done once on any given area.

3) <u>Land Leveling</u>. In addition to the seasonal methods previously mentioned, there is usually at least one major leveling process conducted with large earth movers to produce a finished grade, determined by soil texture and future intended use of the area being leveled.

Most of the leveling is now done using laser land leveling beams to control the operation. Laser leveling makes it possible to level the field with one-tenth of an inch precision.

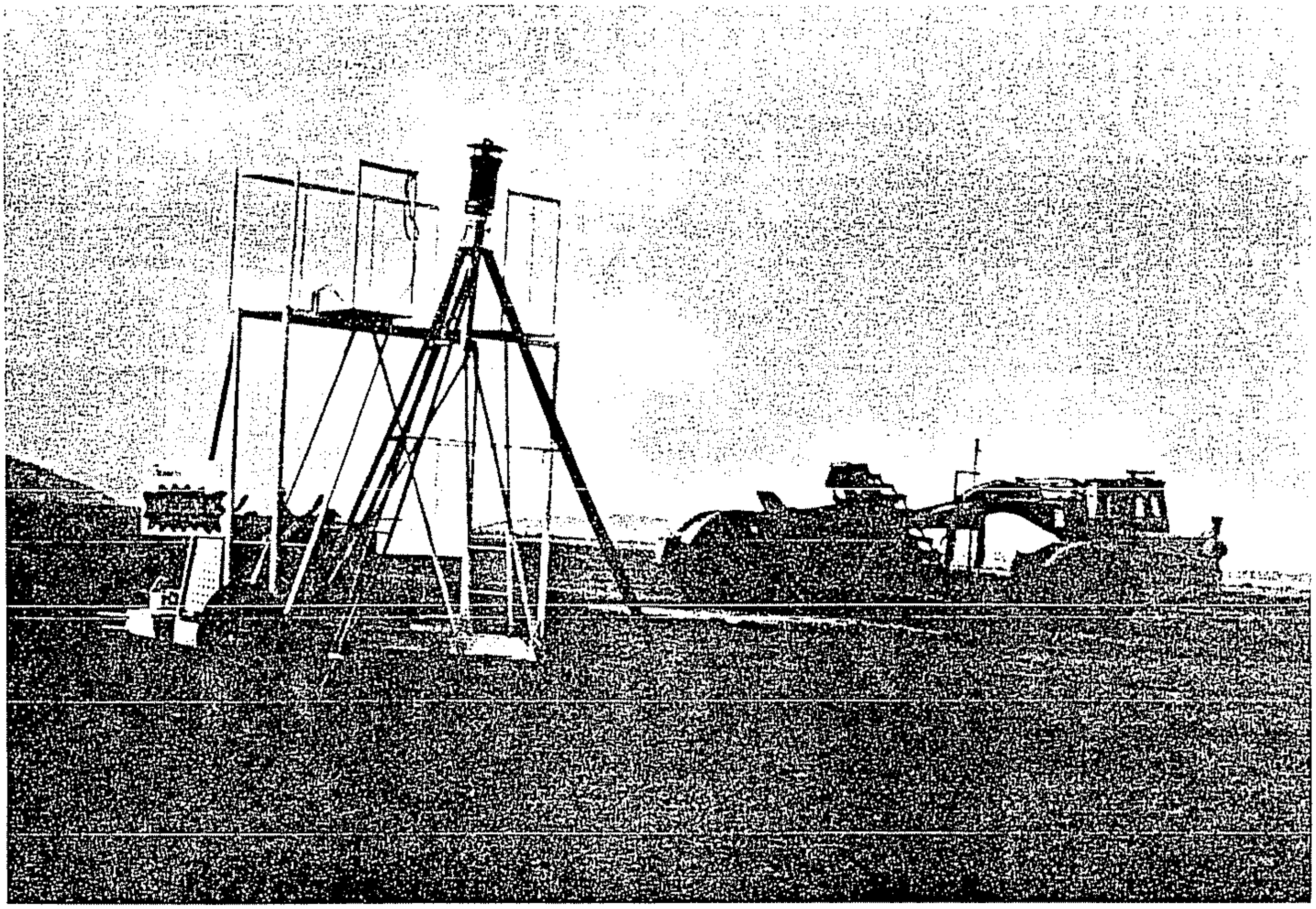
Many farmers have bought their own laser equipment, and "touch-up" their field each year to maintain precision leveling in order to evenly distribute and conserve water.

b. Irrigation Practices

Since less than three inches of rain falls annually in the Valley, irrigation is the most important management practice the farmer has. Crops grown in the Valley vary all the way from field crops to vegetables, and the methods used to irrigate these crops vary accordingly.

1) Sprinkler Irrigation: Sprinklers are used mainly in the Valley to germinate vegetable crops. They provide a micro climate around the young seedling that is more conducive to its early growth. Overall potential irrigation efficiency using sprinklers on Valley soils is only 65-75 percent. This is due to distribution uni-formity problems inherent in sprinklers and very high evaporation losses. After establishing a stand, more efficient methods such as furrow irrigation are used.

2) Furrow Irrigation. Furrow and border irrigation are the two most widely used methods of irrigating in the Valley. Furrow irrigation is accomplished by running water in small channels (furrows) down or across the slope of the field. The water infiltrates into the bottom and sides of the furrows to provide the desired wetting of soil. Proper land leveling to provide uniform slopes is required to achieve high efficiencies in furrow irrigation.



LAZER LAND LEVELING IMPROVES WATER APPLICATION UNIFORMITY AND EFFICIENCY.

Furrows are particularly suitable for irrigating crops which are susceptible to injury if the crown or stems become submerged. In contrast to flooding, furrow irrigation does not wet the entire soil surface; therefore, more time must be allowed for the water to "soak in" in furrow irrigation. Labor in this method is greater than border but much less than sprinkler or drip irrigation.

3) Border Irrigation. Border irrigation uses parallel earth levees or borders, which guide a sheet of water as it moves down the slope. The land between two levees is called a border-strip. Border-strips vary in width from 10 to 150 feet and from 1,000 to 5,000 feet in length.

   This method is often the most efficient for irrigation of densely growing crops such as alfalfa and wheat. It is essential that the land has very little side fall and the surface must be even to achieve high irrigation efficiencies.

4) Corrugation Irrigation. In corrugation irrigation the water flows down the slope in small furrows called corrugations or rills. This method is used on steep ground for irrigating crops such as small pasture and alfalfa. The corrugations are "V" or "U" shaped channels about 2-3 inches deep spaced 12-40 inches apart. The entire soil surface is wetted as the water moves laterally through the soil. This method of wetting the soil is commonly used to germinate crops which have been drill or broadcast seeded

because it minimizes the crusting effect on the surface. Flood irrigation is then used after the plants become established.

5) <u>Basin Irrigation</u>. Basin (dead level) irrigation is relatively new to the Valley. It is the simplest in principle of all methods and labor is minimal. Levees (dikes, borders) are constructed around the areas forming basins. The land inside the basin is level or has a very small amount of fall. A 70-acre field will normally be divided into six individual basins. The dikes remove land from production and interfere with the movement of farm equipment. Many different crops are irrigated by this method. Plants which would be damaged by submergence are grown on beds, and the water flows in the furrows.

Dead level irrigation, as it is called in the Valley, is aptly named. Around 80 percent of the Valley soils are heavy clays and seal over when wetted. If excess water is applied or if a storm occurs after an irrigation, with the very slow infiltration rates, water will pond on the surface for long periods of time. In most cases this will seriously injure or kill the crop. Extremely careful water management is necessary on clay soils with basin irrigation.

6) <u>Drip Irrigation</u>: The application of water to the soil through small orifices is known as drip, trickle, spitter or dribble irrigation. The small orifices, normally

deliver water to a specific area at rates of 1/4 to 2 gallons per hour. Water is delivered through small plastic pipes to the orifices which can be laid on the ground or buried. Water is normally applied at short intervals to meet the consumptive use needs of the crop. Drip systems must have screens and filters for removing moss and suspended particles which would plug the small emitters. Fertilizer is usually injected into the system. Plugging of emitters can be a problem and requires constant checking to assure that all of the plants are receiving enough water.

Drip irrigation is used on sandy soils and on some citrus and high cash crops in the Valley. Salt accumulation at the perimeter of the wetted area occurs and must be leached from the root zone, either by overapplication through the drip system or periodic flooding of the soil. Extreme caution must be exercised during rainstorms. Rains can cause the accumulated salts to migrate back into the root zone, and severe crop damage or failure can occur. It is a general practice to run water through the drip system during a storm to prevent the migration of the salts back into the root zone. This obviously reduces the efficiency of the drip system. A storage reservoir is required when using a drip system.

7) Tailwater Return: Tailwater return, sometimes referred to as pump-back, can be used with most of the preceding methods of irrigation. Tailwater, the excess water which collects at the lower end of the field, is normally stored

for a few hours and pumped back to the upper end of the field where it is mixed with incoming water and used to irrigate other portions of the field. Careful water management is important when using a pump-back system.

c. Irrigation Scheduling Methods

When to irrigate and how much to apply are two basic questions asked by the irrigator. Irrigations must be scheduled often enough to keep the plant alive and producing well. The amount of water applied during each irrigation is a function of the soil type, system efficiency and irrigation frequency.

There are four basic methods used to schedule irrigations in the Valley. They range from observing the plants to complex computer modeling. Each method has advantages and disadvantages.

1) Crop Appearance Method. Crop appearance has been used to schedule irrigations for many years. It is based on a change in plant appearance or color when associated with stress. For some crops this method has been somewhat successful. However, by the time some plants show signs of stress it is too late and yield is reduced. This method tells you when to irrigate but not how much to apply.

2) Calendar Method: The crop is irrigated at a set frequency on a certain number of calendar days with the calendar method. Scheduling with this type of system is very simple. Unfortunately, irrigation efficiency and production can suffer under this type of system. This method does not indicate how much water should be applied and could result in overapplication of water or severe plant stress between irrigations.

3) ET Method (Water Budget Method): This method involves determining the daily evapotranspiration (ET) loss for each crop and subtract-ing that amount from the available soil moisture in the plant root zone. This accounting (budget method) allows the grower to keep track of the soil moisture conditions in each field and predict several days in advance when an irrigation is needed and how much water to apply.

   Various methods have been developed for estimating the amount of water used each day by a crop at a specific site. Some methods involve incoming radiation, wind speed, temperature and humidity measurements. One relatively simple approach has been to relate a crop's daily consumptive use to the evaporation loss from a Class "A" Weather Bureau evaporation pan. Daily pan evaporation values are listed in the local newspaper each day.

   The water budget method must be closely correlated with soil type, salinity, fertilization and stage of growth.

It is a good method for scheduling irrigation but must be continually compared to the actual conditions existing in the field.

4) <u>Allowable Soil Moisture Depletion Method</u>. Soils will only hold a certain amount of water that is available for plant use. This is usually referred to as the available water holding capacity (AWC) of the soil and is closely related to texture. Table III.13 lists the general ranges of available moisture for various textures. In the allowable depletion method, a certain percentage of this moisture is allowed to be depleted from the plant root zone before an irrigation is scheduled. The amount of water to be replaced during each irrigation is the amount depleted from the soil since the last irrigation.

One way of estimating the soil moisture content is by the "feel" method as described in Table III.14. Other more accurate methods of estimating soil moisture depletion involve the use of tensiometers, conductance cells, oven drying soil samples, and the neutron soil moisture probe.

The District currently has a demonstration irrigation scheduling program using the neutron probe. The unit irrigation efficiency in this demonstration program is currently 86 percent.

Table III.13

IRRIGATION WATER MANAGEMENT

Conservation irrigation water management is the act of controlling or regulating irrigation water applications in a way that will satisfy the water requirements of the crop without the waste of either water or soil. It involves applying water in accordance with crop needs, in amounts that can be retained in the soil for crop use, and at rates that are consistent with the intake characteristics of the soil and the erosion hazard of the site.

The table below gives the general range of available moisture holding capacities of the various soil textures when uneffected by salts.

Soil Texture	Available Moisture 1/	
	Range In./Ft.	Average In./Ft.
Very Coarse to Coarse Textured Sand	0.4 - 1.00	0.80
Moderately Coarse Textured Sandy Loams and Fine Sandy Loams	1.00 - 1.50	1.20
Medium Texture - Very Fine Sandy Loams to Silty Clay Loam	1.50 - 2.30	2.00
Fine and Very Fine Texture - Silty Clay to Clay	1.50 - 2.00	1.80
Peats and Mucks	2.00 - 3.00	2.50

Soil textures existing in your fields can be found in your conservation plan. If you do not have one, check at the local Soil Conservation Service office.

The available moisture in saline soils should be reduced according to the table below:

ESTIMATING REDUCTION OF AVAILABLE MOISTURE IN SALINE SOILS 2/

Conductivity of Soil Saturation extract Millimhos/cm (EC x 10^3)	0	2	4	6	8	10	12	14	16
Approximate Reduction in Available Moisture - percent	0	5	11	19	28	38	52	68	84

1/ Revised in accordance with Technical Note, Soils-15, dated June 1969 with attachments dated May 20, 1976.

2/ From "A Proposed Method for Estimating Reduction of Available Moisture in Saline Soils" by Robert E. Fox, USDA-Soil Conservation Service, Soil Science, Vol 83 page 453, June 1957.

CAL. -7-L-14000-141
(Revised Dec. 1977)

Table III.14

GUIDE FOR ESTIMATING AVAILABLE SOIL MOISTURE BY THE "FEEL" METHOD

Available soil moisture remaining	Feel or appearance of soil			
	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine and Very Fine Texture
0 to 25 percent	Dry, loose, single grained, flows through fingers.	Dry, loose, flows through fingers.	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition.	Hard, baked, cracked, sometimes has loose crumbs on surface.
25 to 50 percent	Appears to be dry, will not form a ball with pressure. 1/	Appears to be dry, will not form a ball. 1/	Somewhat crumbly but holds together from pressure.	Somewhat pliable, will ball under pressure. 1/
50 to 75 percent	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure but seldom holds together.	Forms a ball somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and fore-finger.
75 percent to field capacity (100%)	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.	Forms a ball, is very pliable, slicks readily if relatively high in clay.	Easily ribbons out between the fingers, has slick feeling.
At field capacity (100%)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.

1/ Ball is formed by squeezing a handful of soil very firmly.

D. OTHER WATER USES

1. Municipal Water Use

Imperial Irrigation District delivers water to a variety of ultimate users, not only to farmers. Nine cities and towns are delivered water on a wholesale basis directly from canals to each town's treatment facility. These desert communities have the per capita consumption rates listed below in Table III.15.

TABLE III.15 - Municipal Water Consumption

Town or City	1983 Water Delivered Acre-Feet	1983 Population	Gallons/ Capita/Day
Calexico	5,110.0	15,838	288
Holtville	1,516.4	4,637	292
El Centro	6,239.8	26,402	211
Imperial	2,067.0	3,708	498
Brawley	7,960.0	17,160	414
Westmorland	1,102.0	1,718	573
Calipatria	1,337.0	2,706	441
Niland	789.0	1,042	676
Seeley	346.0	1,058	292
Heber	345.0	2,221	139
U.S. Naval Air Station	811.5	2,315	313
TOTALS	27,623.7	78,805	4,137

Population figures are from Imperial Irrigation District's Community and Special Services Section, February 1984. Official Preliminary 1983 Census Results are from the County Planner.

Farmers in rural areas and rural communities also receive water directly from the canal system, treating it as necessary. Water charges are made annually. There are 19,479 residents living in the nonurban areas of the District's water service area utilizing approximately 8,400 acre-feet of water per year. Since water deliveries to rural customers are not measured, this quantity is based on the average county wide usage rate.

2. Industrial Water Use

There is little industry in Imperial Valley, excluding geothermal developments, not within the urban areas. These include:

Holly Sugar Corporation
Simcal Ammonia Producers
Various Cotton Gins and Compresses
Chemical/Fertilizer Producers
Steam Turbine Electrical Generating Station

The approximate annual water use for the above is 20,000 acre-feet.

The development of the geothermal resources requires water for cooling and reinjection. Currently there are three pilot plants operating in Imperial Valley;

East Mesa Geothermal (MAGMA)
Brawley Geothermal (Union-SCE)
Salton Sea Geothermal (Union-SCE)

The annual water use for 1983 was 2,315 acre-feet.

The initial development stages indicate that water usage by geothermal power plants varies with the temperature of the resource but will average 60 acre-feet per year per megawatt.

Development to the predicted 3,000 MW scenario will require about 180,000 acre-feet annually. If steam condensate is not used for cooling throughout the Valley, adverse impacts to water availability and quality could occur. On the other hand, if steam condensate is used for cooling at full field development for the entire geothermal resources, and less than 100 percent reinjection is permitted, no outside sources of cooling water will be required, and no adverse water supply impacts will occur.

3. Recreational and Wildlife Water Use

Recreational users of water outside of city boundaries are lakes, parks and golf courses. The approximate annual water use by recreational facilities is as follows:

Location		AF/Yr.
Wiest Lake and Park		726
Sunbeam Lake and Park		1,034
Finney Lake		1,614
Ramer Lake		1,696
Del Rio Country Club		994
Barbara Worth Country Club		695
International Country Club		382
	TOTAL	7,141

Wildlife uses consist mainly of wetlands habitat enhancement areas. The California Department of Fish and Game maintains approximately 1,400 acres of waterfowl habitat and 360 acres of fish hatcheries.

The Imperial Irrigation District also maintains a 100-acre pond in the New River bottom for wildlife habitat. The approximate annual use for both of these areas is 13,000 acre-feet in evaporation and seepage per year.

Other bulk users of water in the rural areas of Imperial County include schools and cemeteries, and approximate usages are listed below:

User	Acre-Feet Per Year
Riverview Cemetery	269
Memorial Park Cemetery	39
Central Valley Cemetery (Holtville)	16
Central Valley Cemetery (El Centro)	27
Imperial Valley College	400
Meadows Union School	120
Westside School	84
Mulberry School	110
McCabe School	120
Pine Union School	60
Total	1,245

E. SUMMARY

The development of the Imperial Irrigation District as described in previous chapters has culminated in a continually improving system.

Wherever possible, improvements are made on the structural aspects of both the irrigation and drainage systems. Operational improvements are also incorporated to take advantage of the changing aspects of the system. Rules and regulations have been adopted and enforced in order to maintain operational efficiency. These include special water conservation measures put into effect within the last ten years.

The District has looked at system-wide water usage and has focused on its largest customer, agriculture. Irrigation practices have been investigated and wherever feasible, improvements have been encouraged. Other water users, including municipalities and industry, are being monitored and have been taken into consideration in this description.

CHAPTER IV

PAST WATER CONSERVATION PROGRAMS

A. INTRODUCTION

Major water conservation programs by an irrigation district usually require changes in routine at the policy and management level, at the operation and maintenance level, and at the water user level. Changes must be accomplished in a well-planned and orderly fashion, especially in a large and complex district such as Imperial, where large quantities of water are handled; lands are located far from the water source and are irrigated 12 months out of the year; and where high value crops are produced which are often highly sensitive to management of soil, moisture and salinity. Any program measure that disrupts established practices and procedures or attempts to implement structural changes to existing distribution systems more rapidly than can be accommodated within the capability of District personnel and landowners to adapt may well result in an overall failure of the water conservation program. The degree of failure can be measured in crop losses, excessive District costs, and poor relations between the District and landowners it serves.

Districts often proceed with certain water conservation programs desirable both to water users and a district, without an in-depth feasibility study as to benefit/cost or best order of priority. The District's canal-lining program has been somewhat in this category. It was obvious to the District that in addition to reducing seepage losses, lined canals were more economical to operate and maintain than dirt ditches. Farmers prefer lined canals because they reduce seepage damage to adjacent lands, reduce the lands needed for rights-of-way and increase lands available for farming. Where farmers are responsible for maintenance, costs are reduced. The rate at which mutually financed programs can proceed is influenced by funds available, canal delivery schedules, and availability of contractors to do a timely job.

Operational changes and administrative decisions that result in water conservation, such as some of those under the District's 13-Point and 21-Point Programs described herein, can be made without benefit cost analysis, but will succeed only if done gradually, include educational and training sessions of both District operating personnel and water users, and provide for effective communications between District supervising and operating personnel and water users.

The past water conservation programs described in this chapter demonstrate the long-term commitment by the District to water conservation, and to continued improvement of its system and operational procedures to increase efficiencies of delivering water to its farmer constituents. Also, water users have gradually and continuously improved their irrigation and farming practices which have resulted in increased on-farm water use efficiencies and optimum crop production.

The many suggestions offered by individuals and groups described herein are a valuable "data bank" which should be added to as new ideas are presented, and drawn from as periodic review indicates the probable effectiveness of any proposal or "opportunity" stored in the "bank".

B. EARLY DEVELOPMENT

Conservation of water, per se, was not in the minds of the early developers, nor of District engineers during the first several decades of construction of the irrigation and drainage systems, and difficult conditions of operation and maintenance of District facilities.

However, neither is water conservation something brand new to the District. In fact, improvements to the irrigation system during more than three decades have resulted directly in water conservation, because they have contributed to increased efficiency of the system.

Among the first tasks faced by the District, after its formation in 1911, was the need for extensive improvements and repairs to the canal system, as well as for work on the Colorado River levees in Mexico. Furthermore, it was necessary to sell bonds, and in 1915 bonds were sold in the amount of $3.5 million, mainly for purchase of the Southern Pacific properties, with only $500,000 being allocated to improvements. Construction of a new headgate in the Volcano Lake levee and the Cierro Prieto Canal was completed by 1916.

In 1916, realizing the very serious problem of maintaining an adequate water supply, the Board of Directors appointed a board of consulting engineers to recommend improvements. With funding provided by a Second Bond Issue in 1917, in the amount of $2.5 million, construction of the Rockwood Heading and Intake Canal, an extension of the Alamo Canal, was accomplished. Other expenditures were for the following:

Purchase of locomotive, steam shovel, and dump cars for use in the Andrade Quarry and River levees

Construction of Solfatara Canal

Improvements to Levee System and Alamo Canal

Construction of a number of canal headings and small sluiceways both in Mexico and Imperial Valleys

It was not until 1919, after sale of the Third Bond Issue for $2.5 million, that additional improvements were made to the canal systems in Mexico and Imperial Valleys.

The need for drainage became apparent as the 1920's approached, not unlike other reclamation projects where little attention was paid to drainage problems until after they occurred.

District resources, financial and physical, were expended during the late 1920's to construct an open drainage system, and by the end of 1930, 234 miles of deep drains, and 740 miles of lateral drains had been completed. At this time, the District was operating and maintaining about 1,600 miles of irrigation canals and laterals in Imperial Valley, basically the same system in operation today. In addition, through its Mexican company, it was operating and maintaining 130 miles of canals, and about 75 miles of protective levees along the Colorado River, 45 miles of which were equipped with a standard-gauge railroad.

Maintenance, especially the removal of silt from the canal system, required much time and expense.

Recognizing the need to avoid excessive tailwater discharge by water users, the District has periodically adopted Resolutions, and Rules and Regulations toward this purpose.

Regulation No. 34 in District Rules and Regulations adopted in 1922 states in part:

> "...water users wasting water on roads or vacant land, or land previously irrigated, either willfully, carelessly, or on account of defective ditches, or who shall flood certain portions of the land to an unreasonable depth or amount...will be refused the use of water until such conditions are remedied."

This basic regulation has been in effect since 1922.

In 1933, after the drainage system was completed, the Board of Directors adopted a resolution which provided that: (paraphrased)

> District would refuse water service to any water user who intentionally or carelessly permitted flowing of excess irrigation water into drains.

The next two decades were extremely difficult times. The nationwide depression of the 1930's resulted in great financial stress both by Valley farmers and the District. Then in 1934, a severe water shortage caused crop losses and additional hardships, and in fact financial problems continued through the decade. In 1939, a hurricane swept through the Valley, dropping nearly 7 inches of rain which fell nearly continuously for a week. Great damage was done to the District's systems. The following year, in May 1940, the most severe earthquake of the century, to date, caused substantial damage to cities and towns, and several lives were lost. Again, extensive damage to District facilities took place, the principal damage being to the Solfatara Canal in Mexico. The newly completed All-American Canal sustained a horizontal shift of over 14 feet in its right bank not far from Calexico. Again, substantial time and money were expended to make repairs.

With completion of the All-American Canal, which first delivered water in 1941, providing the Valley with its first silt-free water supply, and improving economic conditions of the post-war period, the District began improving its systems. Old timber structures were replaced with concrete. Corrugated metal pipes in culverts and flumes were replaced with concrete pipe. The County improved its road system, constructing numerous bridges and cooperating with the District in replacing old and installing new siphons. As those roads were paved, the District's operations improved due to better access to checks and delivery structures.

During this period the District was constantly and diligently protecting and developing its rights to use and adequate water supply from the Colorado Rive.

During the past four decades the District has initiated many water conservation programs, and additionally participated in various programs in cooperation with government agencies.

Various structural programs have been initiated and continued by the District in cooperation with private individuals and public entities. Operational and administrative programs designed to conserve water have been put into practice. In addition to taking part in cooperative ventures, the District has offered public education programs and has encouraged innovative on-farm irrigation practices.

These and programs are described within this chapter and from the doundation of future water conservation plans.

C. STRUCTURAL PROGRAMS

Structural programs to conserve water include definite physical changes to the water conveyance and usage system that will bring about benefits more or less independently of user practices. An example would be the lining of canals to reduce seepage losses.

1. Canal Lining

The District began a program of concrete lining canals and laterals in 1954. The program provided that the landowner submit a request to the District to concrete line the reach of canal contiguous to his land, and agrees to pay a share, varying from 25 to 30 percent of the lining cost, furnish rights-of-way and earth fill as necessary for construction of the embankment.

Under this program, 871 miles of canals and laterals, over half of the District's water conveyance system, have been concrete lined through 1984.

The cost sharing program between landowner and District had two benificial aspects regarding water conservation. First, Where canal seepage was causing a problem, a landowner would request that a canal be lined; hence some of the canals with high seepage rates were lined under the program. Secondly, by using a cost sharing program the next results was that more miles of canal were lined and there was a greater saving in seepage losses. The real cost savings to the District has not been determined because no values has been placed on farmer supplied earth fill. Considering haul distances this could be the most costly item.

In addition to concrete lining, about nine miles of laterals have been replaced with concrete pipe, primarily through portions of the Cities of Brawley, El Centro, and Holtville. Table III.2 shows the mileage of District canals and drains in earth section, concrete lined, and pipelined, as of December 31, 1983.

It is difficult to make a reliable estimate of the reduction of seepage resulting from canal lining. The seepage per mile of lateral derived from the USBR study on canal lining averages 135 acre-feet of seepage per mile of lateral. Using this number, the lining of canals is currently saving (881 x 135) about 119,000 acre-feet per year. The total savings from 1954 thru 1983 is about 1,600,000 acre-feet. This estimate is probably low because the canals which have been lined includes some oth the mat pemiable.

In addition to lining of District lateral canals about 80% of farm head ditches have been lined. This amounts to 2,400 miles. the District specifically use private contractors for canal lining District canals so that the contractors are avaliable in the Valley for farm ditch lining.

2. Regulatory Reservoirs

The District has four regulating reservoirs in operation providing a total storage capacity of 1,570 acre-feet. One reservoir is located on each of the three main canals - East Highline, Central Main and Westside Main. The fourth and newest reservoir, the Herman "Red" Sperber Reservoir, began operating May 1, 1983, and stores water from the Rositas Canal.

Reservoir	Capacity
Singh	400 AF
Sheldon	1,300 AF
Fudge	2,400 AF
Sperber	2,100 AF
Total	6,200 AF

A total of $3.3 million was spent for construction of the four reservoirs.

3. Seepage Recovery Lines

The District has constructed six miles (twelve 1/2-mile sections) of drainage lines parallel to the East Highline Canal to recover canal seepage losses. Water entering these drains is pumped back into the canal for delivery to farms. Through 1982, it is estimated that nearly 210,000 acre-feet have been returned to the distribution system. Total funds expended for seepage recovery lines were $492,000, and approximately $50,000 per year is budgeted for operation, maintenance and power costs associated with the seepage recovery program. (See Table IV.1)

D. Operational Programs

Operational programs refer to changes in operational procedures that have been initiated to effect water conservation.

1. Automated Controls

The District has installed remote electronic monitoring and control devices at 22 major structures, including the All-American Canal and the four reservoirs.

The Water Control Section, under the direction of the Watermaster, operates the remote-control structures in the District. The hydrographers and other field personnel can provide manual operation of these facilities in case of power outages and emergencies.

2. Radio Equipment

All water operation personnel have radio equipment for immediate exchange of information. The District also has installed radio equipment in all the division offices (where water orders are received and processed) as well as in the operating headquarters. Effective communications between farmers and operating personnel, zanjeros and their supervisors and water clerks, and communications among the various operating entities within the District improve

Table IV.1

WATER RECOVERY DRAINS PARALLEL TO EAST HIGHLINE CANAL

Year	DP-17 Plum to Pine Acre-Feet Recovered	DP-17 Cost	DP-18 Pear to EHL Lat. 10 Acre-Feet Recovered	DP-18 Cost	DP-19 EHL Lat. 10 to Lat. 11 Acre-Feet Recovered	DP-19 Cost	DP-20 Oat to Oasis Acre-Feet Recovered	DP-20 Cost	DP-21 Highway 80 to EHL Lat. 8 Acre-Feet Recovered	DP-21 Cost	DP-22 EHL Lat. 8 to Pear Acre-Feet Recovered	DP-22 Cost	DP-23 Oak to Moss Acre-Feet Recovered	DP-23 Cost
May to Dec. 1967	736	$ 287	-	-	-	-	-	-	-	-	-	-	-	-
1968	1 288	510	467	$ 182	262	$116	140	$ 98	96	$ 54	121	$ 58	-	-
1969	1 449	516	1 508	580	723	353	697	323	1 120	455	713	355	-	-
1970	1 321	479	1 416	533	658	332	653	314	1 088	447	621	328	925	$ 361
1971	1 349	487	1 455	544	570	304	640	309	1 053	436	593	317	1 351	533
1972	1 207	451	1 388	526	568	306	599	295	1 123	456	652	332	1 297	510
1973	1 130	432	1 410	531	511	284	589	287	936	431	658	334	1 272	513
1974	1 109	590	1 363	680	599	384	587	304	889	532	588	385	1 340	700
1975	1 072	790	1 220	889	512	448	301	263	932	606	499	437	1 190	927
1976	984	755	1 084	839	470	422	371	314	865	717	507	461	1 269	948
1977	1 060	928	663	643	397	428	397	384	885	878	347	371	1 347	1 119
1978	977	977	559	679	390	462	441	439	911	915	242	438	1 298	1 272
1979	1 113	1 252	693	841	260	406	515	528	921	1 104	243	524	1 298	1 510
1980	922	1 245	676	992	194	339	475	630	778	1 102	281	580	1 313	1 795
1981	948	1 335	788	1 195	390	367	309	780	866	1 350	643	822	1 334	1 774
1982	1 089	1 913	811	1 648	377	435	258	1 125	860	1 796	482	997	1 240	2 199
1983	1 154	2 221	938	2 157	355	598	206	1 204	860	2 066	494	1 351	1 150	2 482

Year	DP-24 Ohmar to Oleander Acre-Feet Recovered	DP-24 Cost	DP-25 Orange to Ohmar Acre-Feet Recovered	DP-25 Cost	DP-26 Oxalis to Orange Acre-Feet Recovered	DP-26 Cost	DP-27 EHL Lat. 11 to Lat. 12 Acre-Feet Recovered	DP-27 Cost	DP-28 Oasis to Orient Acre-Feet Recovered	DP-28 Cost	Totals Acre-Feet Recovered	Totals Cost	Average Power Cost Per Acre-Foot
May to Dec. 1967	-	-	-	-	-	-	-	-	-	-	736	$ 287	-
1968	-	-	-	-	-	-	-	-	-	-	2 374	1 018	$0.43
1969	-	-	-	-	-	-	-	-	-	-	6 210	2 582	0.42
1970	-	-	-	-	-	-	-	-	-	-	6 682	2 794	0.42
1971	406	$ 143	-	-	-	-	-	-	-	-	7 417	3 073	0.41
1972	1 854	653	1 361	$ 627	-	-	-	-	-	-	10 049	4 165	0.41
1973	1 795	636	1 489	648	3 309	$1 120	2 731	$1 012	-	-	15 830	6 228	0.39
1974	1 850	884	1 109	603	3 714	1 825	3 195	1 548	2 369	$1 063	18 712	9 498	0.51
1975	1 460	1 124	1 300	995	3 368	2 362	3 046	2 097	3 094	1 822	17 994	12 760	0.71
1976	1 388	1 168	1 370	1 195	3 126	2 387	3 062	2 271	3 296	2 092	17 792	13 569	0.76
1977	1 760	1 388	1 210	1 388	3 047	2 665	2 947	2 566	3 244	2 412	17 304	15 170	0.89
1978	1 833	1 569	1 322	1 544	3 704	3 475	3 039	2 863	3 255	2 633	17 971	17 266	0.96
1979	1 639	1 827	1 146	1 780	3 332	3 777	3 014	2 469	3 449	3 383	17 623	20 401	1.16
1980	1 625	2 138	1 113	2 061	3 357	4 469	2 883	3 836	3 499	3 983	17 116	23 171	1.35
1981	1 456	1 915	1 249	2 139	3 235	4 339	3 021	4 040	3 321	3 923	17 560	23 979	1.37
1982	1 523	2 346	1 188	2 741	3 460	5 966	2 947	5 213	3 148	4 956	17 383	31 334	1.80
1983	1 478	2 666	1 287	3 137	3 373	6 788	2 794	5 691	3 052	5 928	17 142	36 289	2.12

Mileage:
.50 Mile - Total 6.00 Miles
Power costs calculated in Engineering Section

efficiency of daily operations and also provide instant communication among personnel during emergencies. Better communications permit greater operational flexibility in switching water deliveries from one farmer to another, thereby reducing operational spills.

3. Personnel Training

As operational methods are changed, structures built or modernized and other system parameters upgraded, the District has established a training program for all Water Department employees to keep abreast of operational or other changes. All new employees tour the District facilities to get an overall view of the District's operations. Specialized training in water measurement and management is given to new zanjeros and hydrographers. Each division has monthly meetings to discuss operations, conservation, safety, etc. Daily on-the-job training is an integral part of the training program. As conditions in the field change, supervisors inform their personnel of new procedures and methods.

E. Administrative Programs

Administrative options are available to public distributors of water. An example is the establishment of incremental water rates to encourage water conservation.

1. <u>13-Point Program</u>

Imperial Irrigation District in July 1976 supplemented its existing water conservation efforts with a stringent 13-Point Program. Included in the program are:

(1) Construction of a water-regulating reservoir on the Westside Main Canal;

(2) Reconstruction of farm outlet boxes, as required;

(3) Employment of an adequate number of water-regulating personnel to effect more efficient deliveries, as the system will permit;

(4) Daily inventory of surface field discharge, charging users who needlessly waste water an assessment for that day equal to three times the scheduled water rate;

(5) Development of surface water evaporation ponds;

(6) Preliminary studies for a regulating reservoir on the Central Main Canal;

(7) Study relating to water recovery lines paralleling the East Highline and Westside Main Canals for seepage recovery which is now going into drainage system and to Salton Sea;

(8) Providing free drainage water to persons willing to pump and use same;

(9) Continuing the concrete lining program;

(10) Initiating a record of accrued water use computerized billing;

(11) Installation of radio equipment in all water conservation-related vehicles to afford immediate communication with supervision;

(12) Initiation of an irrigation management services program;

(13) Delivery of water off-schedule when and wherever possible.

The overall goal of the 13-Point Program was to improve water use efficiency within the District and reduce inflow to the Salton Sea.

2. Water conservation Advisory Board

The Board of Directors of the District recognized the need to continue and expand water conservation efforts and in 1979, appointed a Water Conservation Advisory Board made up primarily of District farmers. The purpose of the Advisory Board is to make recommendations to the District Board regarding the implementation of further water conservation measures. Meetings of the Advisory Board were held on a regular basis and resolutions were adopted by the Board, setting forth suggested additional water conservation measures. The recommendations presented by the Water Conservation Advisory Board are reviewed by the District Board and in 1980, the District Board adopted a 21-Point Program proposed by the advisory Board and intended to supplement the original 13-Point Water Conservation Program which was adopted in 1976.

The Water Conservation Advisory Board has remained active since its formation and continues to work with the Board of Directors of the District in order to obtain more efficient water use within the District.

3. 21-Point Program

The 21-Point Water Conservation Program recommended by the Water Conservation Advisory Board and adopted by the Board of Directors of the Imperial Irrigation District is set forth as follows:

(1) The District shall establish a penalty of one hundred dollars ($100.00) for the unauthorized adjusting of delivery gates, which results in a change in the amount of water being delivered;

Furthermore, whenever a water order is in the process of being pumped through a sprinkler or gated pipe system and the operator-user experiences a mechanical failure of the subject equipment, said operator-user shall be permitted to discontinue his water delivery for a period of not more than three (3) hours. The free time permitted under this schedule shall be considered as separate instances, but in no event shall the combined hours so considered exceed three (3) hours before a triple charge is to be assessed;

(2) The concept of installing gate control devices of a standard design is recommended and supported, such devices to be installed on structures accommodating gates which are owned, operated and maintained, as well as regulated, under the jurisdiction of the District and its personnel;

(3) Application of the assessment charge shall apply on the same basis to all types of irrigation, with the following exceptions:

(a) The percentages of surface runoff allowed when water is being used to irrigate plowed or flat unseeded ground shall be five percent (5%) for the last day of said irrigation; no measurable waste shall be allowed for any previous days.

(b) When water is being run in furrows to germinate crop seeds and establish a stand, no assessment charge shall be made unless one of the two consecutive measurements showing fifteen percent (15%) or more runoff is made between 12:00 noon and 6:00 p.m.

(4) In the event a water user is receiving more than his confirmed order, said surplus shall be subtracted from his surface runoff for the purpose of determining if his runoff is excessive;

(5) In no event shall any water user be assessed unless his runoff is fifteen percent (15%) or more of his running order irrespective of the quantity of water the user is receiving;

(6) Any surface runoff measurement made within four (4) hours after the District has reduced the quantity of water delivered shall apply to the order in effect before said change;

(7) The application of an assessment charge based on waste measured after the delivery gate is closed shall apply on the same basis as when water was actually running. Any assessment made after the gate is closed shall be based on the order last running;

(8) In no event shall the user pay more than triple the normal charge for water, except when he adjusts the delivery gate without permission;

(9) All net proceeds from surface runoff assessment charges shall go into a special fund for conservation purposes other than the concrete lining of ditches;

(10) All District personnel whose duties include checking of surface runoff will initial any waste assessment sheets issued;

(11) Changes can be made for the last day of a run by notifying the District not later than 3:00 p.m. of the preceding day;

(12) When a water user requests an adjustment in the quantity of water delivered not to exceed two (2) feet, the District shall be obliged to honor the same if it is within the ability of the District's system to accommodate such request and the water user notifies the zanjero in advance of beginning his daily run. The zanjero of said run shall obtain approval to make said change from his respective superior or section;

(13) A reduction in the water order shall be made to apply to the last twelve (12) hours water is run, providing that the District is notified in advance but not later than 3:00 p.m. preceding the time the order is changed. No penalty shall be charged for said reduction as long as the same does not exceed fifty percent (50%) or five (5) feet of the order as confirmed, whichever is less. Water returned with notice after 3:00 p.m. or which exceeds the quantity that this rule authorizes shall be subject to an assessment equal to two times the regular water rate;

(14) By notifying the District before 3:00 p.m., orders can be adjusted for the last twelve (12) hours of the run, up to fifty percent (50%) of the confirmed order or five (5) cubic feet/second, whichever is less;

(15) Finish heads can be ordered up to 3:00 p.m. of the day preceding the day of delivery;

(16) By notifying the District before 7:30 a.m. of the last day of a run, an order can be adjusted up to fifty percent (50%), without penalty;

(17) One-day orders shall be checked by the appropriate District employees on the same basis as any other water order. For the application of the assessment charge, the first was measurement shall not be made later than eighteen (18) hours after the beginning of the day's water delivery;

(18) The District shall secure whatever additional radio equipment that is necessary to improve communications between the farmers and Water Department personnel;

(19) The Water Department of the District shall make six (6) wastewater recorders available to be installed at various locations within the service area boundaries as defined;

(20) The District shall prepare a monthly water information bulletin for distribution which shall include information submitted to the District by a committee to be appointed by the Water Conservation Advisory Board, and from other sources as required for the purpose of assisting the water user in using all water beneficially;

(21) Routine canal cutouts shall be accomplished once every eight (8) weeks, except when special circumstances require more frequent cutouts.

The 21-Point Water Conservation Program does not generally expand upon the water conservation measures set forth in the 13-Point Program but rather, defines policies adopted by the Board for administering and enforcing the 13-Point Program.

F. EDUCATIONAL PROGRAMS

The District has implemented a series of educational programs to encourage water conservation within the Valley. These range in complexity from public meetings to full-scale demonstration programs.

1. Demonstration Tailwater Recovery Systems

In order to properly refill the moisture removed from the root zone on the tail end of the field, tailwater runoff is usually necessary. Using a pond to collect the tailwater and a pump to recycle it, runoff can be reduced.

In 1983, the District conducted three tailwater recovery demonstrations with a portable diesel pump and aluminum pipe. The demonstrations were fairly successful, and tailwater was reduced to 15 percent. The pump and pipe were loaned to the District for a short period of time. No further demonstrations have been done.

2. Modified Demand Irrigation Trial

The District normally delivers water for a period of 24 hours and strives to deliver it within 10 percent of the farmer's order. The farmer can usually determine his field's moisture requirements within 10 percent. On an irrigation, the farmer might order 10 percent more than he needs and the District might deliver 10 percent less than ordered. The result would be the correct amount of water applied to the field.

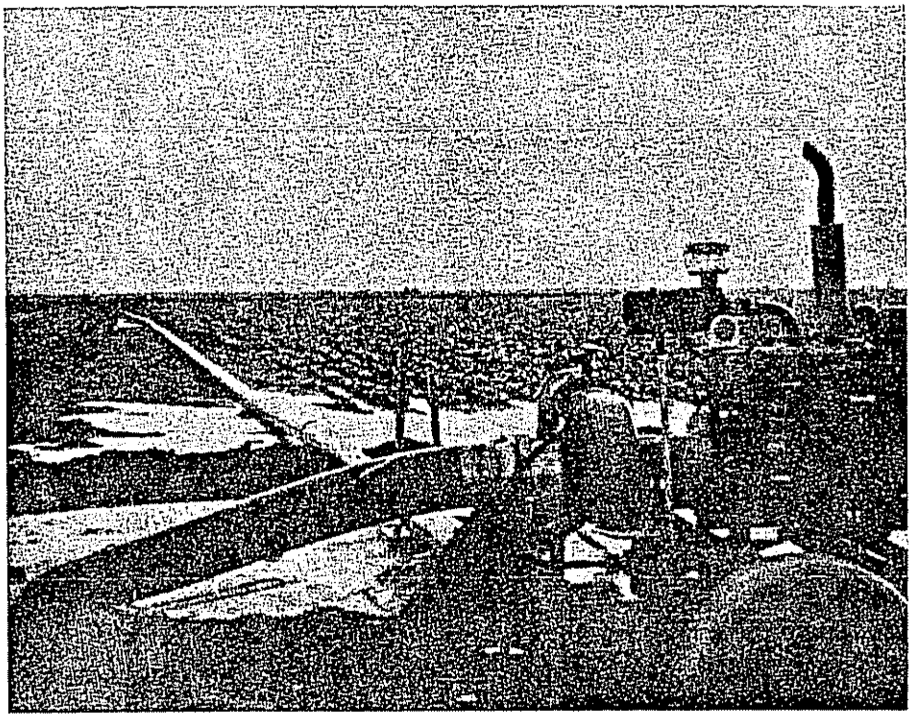
Even if the District deliveres the exact amount of water the farmer ordered it may not be the quantity needed to irrigate the field. That is why many farmers have said, "I wish the District would deliver the amount of water the field needs, not what I order." With this thought in mind, the Modified Demand Irrigation Trial was conceived.

This project was started on a single zanjero run which consists of five laterals off the East Highline Canal. If possible, water orders on this run can be terminated up to four hours before or after the regular ending time. This allows for a combined error in ordering of 16 percent. An analysis of the irrigation efficiency on the run has not been completed at this time. If properly managed and implemented, tailwater should be reduced on this run. Since changes are being made at odd times a substantial increase in District labor is required to implement this program.

3. Public Meetings

During July, August, September and October of 1983, the District held several meetings with area farmers to discuss current water issues including water conservation. Specifically, the meetings were held on July 26 in El Centro, September 6 in Calexico, September 11 in Holtville and October 8th in Calipatria. Each meeting was attended by Board members and staff. Attendance by area farmers varied from 15 - 30 persons at each meeting.

The format of each of the above meetings varied slightly, but the presentations by the District were consistent. Summary of Decision 1600 by the State Water Resources Control Board and the District's rights to Colorado River water; outline of the proposals regarding water conservation measures being considered by the District staff; and report on the status of discussions with Metropolitan Water



THE BENEFITS OF A TAILWATER RECOVERY SYSTEM BEING DEMONSTRATED BY THE DISTRICT.

EXHIBIT IV.1

District regarding a water exchange agreement. The farmers at each meeting had many questions about all these subjects and some offered recommendations.

In addition to holding public meetings, the District mailed out 478 questionnaires to agricultural water users formulated to receive input on present water conservation measures. In all, 147 responses were received. The majority of those responding felt the District was doing a good job of delivering water and that a conservation program was necessary.

An internal survey of District water delivery personnel was also conducted to receive input on the District's Water Conservation Program and will be evaluated.

4. <u>Field Irrigation Demonstration and Training</u>

Proper management and measurement of irrigation water in the District are necessary to achieve high irrigation efficiency. Field irrigation demonstrations in conjunction with the Irrigation Scheduling Program have been conducted.

The agenda usually consists of:

Irrigation Scheduling with the Neutron Probe;
How to Measure Water;
Cutback Irrigation;
Irrigation with minimum tailwater.

A small irrigation training program was implemented in 1983. Several farmers and irrigators were trained to observe and record the stream advance and tailwater in border strip irrigation.

Adjustments were then made during the irrigation to reduce the amount of tailwater. Unit irrigation efficiencies of 90 - 95 percent were achieved during the training period.

Previously, unit irrigation efficiencies of 70 - 75 percent had been monitored. During 1984 these fields were monitored and unit efficiencies increased to 85 - 95 percent. When unit irrigation efficiencies approach these levels, case by case evaluations must be made to determine whether irrigation uniformity is being adversely affected to the extent that crop rpoduction problems or soil salinity problems will result. Although limited in size, this program was very successful.

5. <u>Regulation No. 39 - Tailwater Structures</u>

In 1984 the District revised Regulation No. 39 of it's Rules and Regulations (see appendix) to provide the District with tailwater structures while at the same time to facilitate the reasonable accurate measurement of the tailwater discharge from each farmed unit.

G. COOPERATIVE PROGRAMS

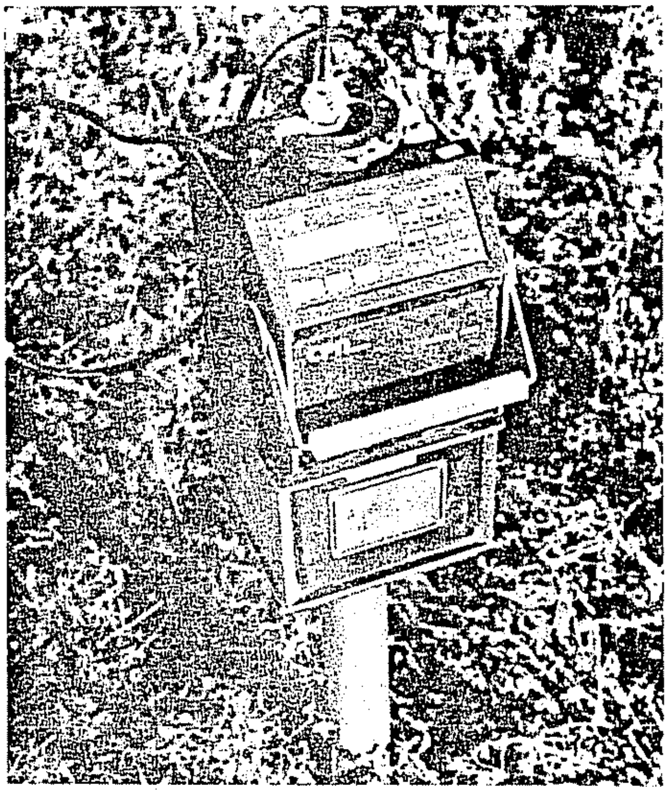
The District has been involved in various cooperative studies and programs, researching innovative water conservation methods. Different levels of involvement have been required of the District.

THE SUPERVISOR OF WATER CONSERVATION EXPLAINING HOW TO IRRIGATE WITH MINIMUM TAILWATER.

EXHIBIT IV.2

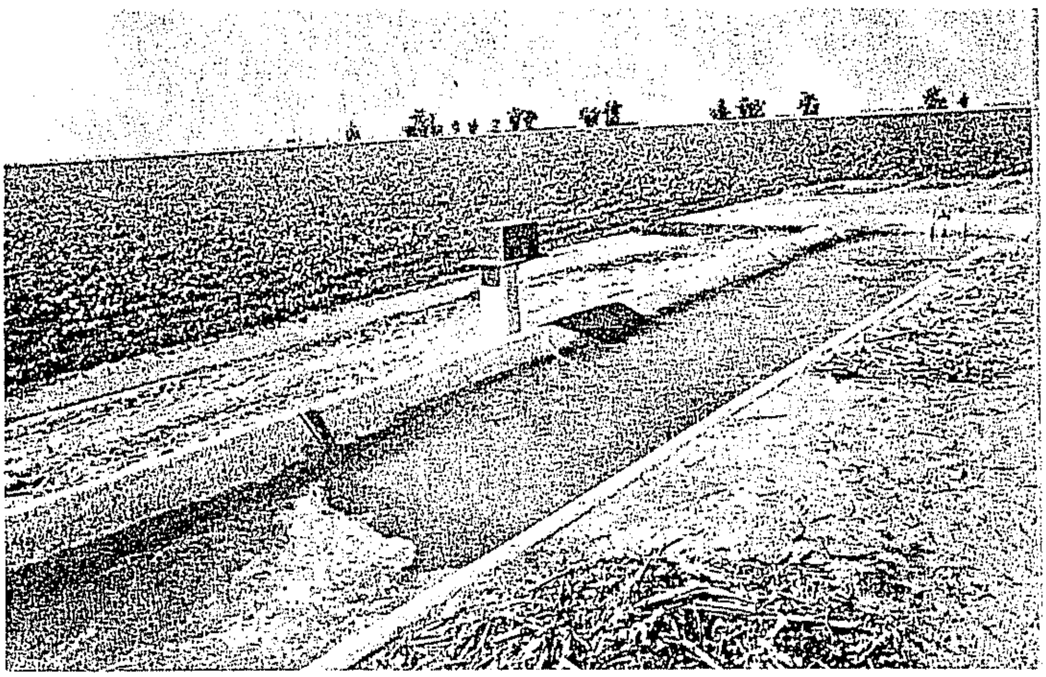
AN IID IRRIGATION TECHNICIAN TRAINING AN IRRIGATOR TO USE NEW IRRIGATION TECHNIQUES.

EXHIBIT IV.3



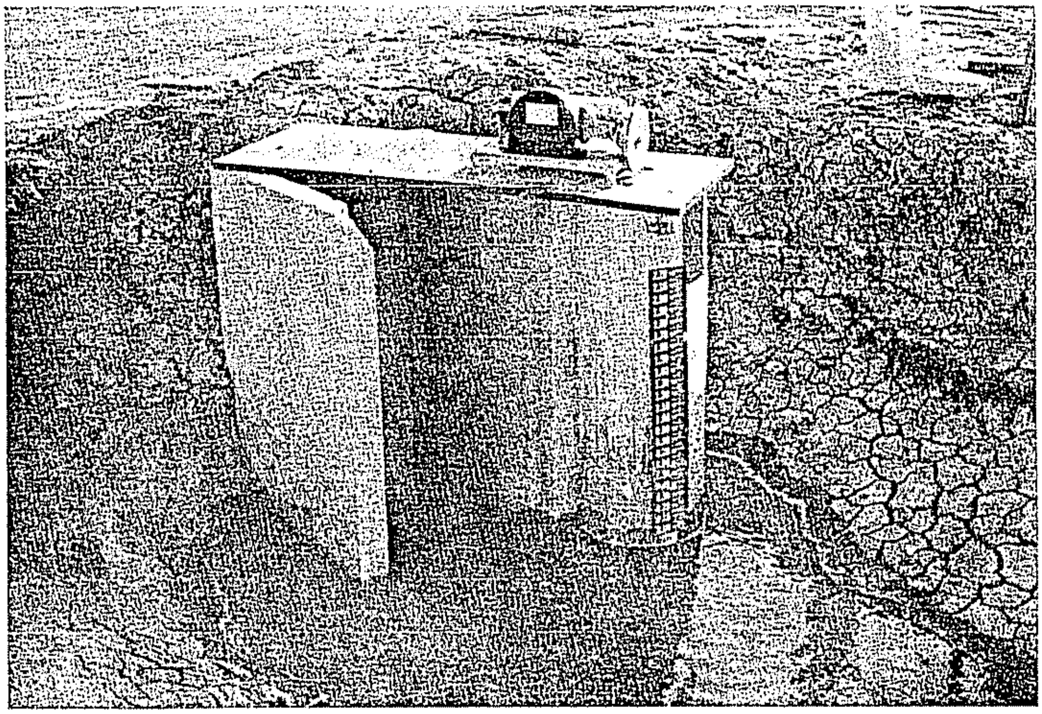
A NEUTRON PROBE IS BEING USED TO MEASURE THE MOISTURE IN THE SOIL.

EXHIBIT IV.4



A WATER LEVEL RECORDER IS RECORDING THE DELIVERY OVER A BROADCRESTED WEIR

EXHIBIT IV.5



A WATER LEVEL RECORDER INSTALLED ON A STANDARD TAILWATER STRUCTURE.

EXHIBIT IV.6

1. <u>Irrigation Scheduling Program</u>

a. History and Summary of Program

The Imperial Irrigation District, in cooperation with the U. S. Bureau of reclamation, started a demonstration Irrigation Scheduling Program in September 1981. The purpose was to identify on-farm opportunities for conserving water and to determine the costs that farmers would incur to conserve water.

The Program involves about 10,000 acres on which neutron probes were used to monitor soil moisture depletion, schedule irrigation dates, and determine the amount of water to be applied. Water-level recorders were also used to measure delivery and tailwater. The growers in the program were contacted monthly to review their progress. Altogether 56 growers have cooperated in the program to date.

b. District Staff and Dollar Contribution

	1982	1983	1984
Salaries	$68,383.20	$68,383.20	$75,947.83
Benefits and Overhead	23,250.29	23,250.29	26,581.74
Vehicles	17,893.98	17,893.98	21,755.22
	$109,527.47	$109.527.47	$124,284.79

c. Acreage Served

	1982	1983	1984
Alfalfa	7,553	7,479	5,477
Sugar Beets	2,094	2,430	2,259
wheat	2,583	1,802	3,013
Cotton	2,468	1,397	2,561
Melons	70	312	0
Asparagus	140	70	0
Onions	72	0	359
Tomatoes	142	0	140
Carrots	80	140	0
Barley	0	72	0
Bermunda	0	0	270
Total Acres	15,202	13,918	14,079
Total Sites	251	216	200

d. Scheduling

Two probe readers monitor the sites once or twice a week. The data is then plotted on the Soil Moisture Charts. Irrigation dates and the amount of water to apply are predicted by the Water Conservation Specialist. The grower is notified of the recommendation by telephone and/or a postcard.

e. Summary of Data

	1982			1983			1984		
	Water "/Ac.	T.W. %	Irrig. Effic.	Water "/Ac.	T.W. %	Irrig. Effic.	Water "/AC.	T.W. %	Irrig. Effic.
Alfalfa	77.0	12	88	67.6	12	88	65.6	13	87
Cotton	60.2	16	84	63.8	17	83	53.8	17	83
Wheat	*	11	89	24.9	12	88	34.1	13	87
Sugar Beets	*	24	76	49.9	22	78	55.6	24	76
Asparagus	*	23	77	*	23	77	--	--	--
Watermelons	*	26	74	*	26	84	--	--	--
Carrots				*	12	88	--	--	--
Tomatoes							*	30	70
Bermuda							*	10	90
Onions							53.0	22	78

f. Impacts and Benefits

Generally, yields have been about the same and irrigation efficiency has improved.

The average unit irrigation efficiency for all the fields monitored in the program is 86 percent.

* = entire crop season not monitored

2. Drain Water Reuse

A program initiated in 1976 permits farmers to utilize drainage water, free of charge, for irrigation or reclamation. The effect of this program is to reduce inflow to the Salton Sea and encourage water use to its ultimate capability. The California Department of Fish & Game in cooperation with the District, utilizes drain water to maintain approximately 1,400 acres of wildlife habitat adjacent to the Salton Sea. The District has also created a 100-acre wildlife habitat in the New River bottom using reclaimed water.

3. U.S. Conservation Research Center, Brawley
(now known as Desert Research Station)

The District has cooperated for many years with this important USDA facility in several ways.

a. Underground Soil Lab

In 1969, the District helped the Research Center install an underground soil column laboratory.

b. Lysimeter

In 1970, the District constructed a 13' wide x 21' long x 5' deep, weighing lysimeter to determine water consumption by crops for use by the Research Center.

c. Reservoir

In 1971, the District helped construct a 2 AF reservoir and pumping station at the Center.

Table IV.2

Crop Factors for Conversion of Pan Evaporation to Crop Evapotranspiration

Month	Wheat 1/	Barley 2/	Beets 3/	Cotton 4/	Alfalfa 5/
January	0.32	0.51	0.75		
February	0.73	0.66	0.67		
March	0.78	0.82	0.64		0.70
April	0.79	0.57	0.66	0.31	0.65
May	0.57		0.69	0.30	0.66
June			0.59	0.57	0.73
July				0.51	0.84
August				0.49	0.67
September				0.59	0.73
October			0.21	0.25	0.70
November			0.41		0.78
December	.043		0.49		0.50

1/ Irrigated up December 20. Harvested May 25.

2/ Irrigated up december 23. Harvested May 14.

3/ Irrigated up October 1. Harvested July 4.

4/ Irrigated up April 1. Harvested November 25.

5/ Irrigated up previous fall.

Source: USDA Research Center, Brawley (Compiled by A.J. MacKenzie)

Table IV.3

Sample Calculations for Irrigation Scheduling Using Daily Pan Evaporation Inform

Date	Input (In.) 1/ Irrigation	Output (In.) Pan E	Crop Factor	Crop ET	Soil Water Balance (In Carry-over	Remaini
April 2	4.2	0.29	0.7	0.20	1.80	5.80
3	0	0.20	0.7	0.14	5.80	5.66
4	0	0.30	0.7	0.21	5.66	5.45
5	0	0.43	0.7	0.30	5.45	5.15
6	0	0.42	0.7	0.29	5.15	4.86
7	0	0.32	0.7	0.22	4.86	4.64
8	0	0.34	0.7	0.24	4.64	4.53
9	0	0.16	0.7	0.11	4.53	4.24
10	0	0.41	0.7	0.29	4.24	4.10
11	0	0.20	0.7	0.14	4.10	3.96
12	0	0.20	0.7	0.14	3.96	3.69
13	0	0.38	0.7	0.27	3.69	3.46
14	0	0.33	0.7	0.23	3.46	3.23
15	0	0.39	0.7	0.27	3.23	2.96
16	0	0.39	0.7	0.27	2.96	2.69
17	0	0.52	0.7	0.36	2.69	2.33
18	0	0.34	0.7	0.24	2.33	2.09
19	0	0.27	0.7	0.19	2.09	1.90
20	4.0	0.19	0.7	0.13	1.90	5.77
21	0	0.36	0.7	0.25	5.77	5.52

1/ Net water actually added to the crop's root zone in the soil. Surface runoff a drainage waters not included.

2/ Sugar beet crop grown in a clay loam soil with a three-foot rooting depth is calculated to hold 6.0 inches of available water. Irrigations scheduled when two-thirds of available water was used or when the soil water balance was depleted to 2.0 inches.

d. Evaporation Data

The District installed evaporation pans and other weather instruments at four representative locations throughout the Valley in 1974, in cooperation with the USDA Research Center in Brawley, where a weather station with pan had been in service since 1960. The daily measurements from the 5 stations have been furnished to the local papers and published daily. The farmers then can use this information to calculate the amount of water the crop has used in much the same way that he balances his checkbook.

The use of pan evaportion information for irrigation scheduling is a matter of setting up a water budget: keeping track of the available water supply in the soil and balancing the soil water inputs (irrigations) with the crop water outputs (evapotranspiration.)

Knowledge of the soil and crop fators for the specific soil and crop involved and use of the daily reported pan evaoration amounts, enables the farmer to calculate how much of the input water has been used by the crop. A prediction for future irrigations may be made also if a history of pan evaporation information is obtained however, a predicted irrigation schedule can be adjusted to compensate for any variation in weather conditions that may be different from the historical average.

In balancing the irrigation inputs against the evapotranspiration outputs, a grower simply balances the soil water content by periodic irrigations at certain times to replace the quantity used by the crop. The steps to implement this method are:

(a) Determination of the water holding capacity of the soil;

(b) Determination of the rooting depth of the crop;

(c) Steps a) and b) will give the amount of water available to the crop;

(d) Measurement of irrigation water added to the crop's rooting depth in the soil;

(e) Daily measurement of evaporation (Pan E) from a standard Class A, Weather Bureau evaporation pan and conversion to the appropriate crop evapotranspiration (Crop ET) by use of the monthly crop factor given in Table IV.2;

(f) Subtract the amount of water lost by evapotranspiration as calculated in Step 2) from the amount of water in the crop's rooting depth, step c);

(g) When the water lost by evapotranspiration is equal to approximately one-half to two-thirds of the available water in the crops rooting depth, replace it by irrigation.

An example of a procedure to use for this water budget method is shown in Table IV.3 for an irrigation interval during April for the sugar beet crop previously mentioned. In this example at least 3.9 inches of irrigation water replaced in the rooting depth were needed on the 18th day to maintain the proper supply of water in the soil. With each irrigation input the water budget is adjusted to start the water use cycle over again.

This method of scheduling irrigation by the use of pan evaporation data can be used on all crops for which crop factors are known. Research is continuing to obtain factors for more crops and to verify the accuracy of the ones currently being used. Use of the method will allow growers to maintain soil water for crops more accurately and at levels that are optimum for maximum production. It gives growers a procedure also for determining the exact time to irrigate and how much water to apply. With the information now available even the next date of irrigation can be predicted.

e. Irrigation Efficiency

In 1977, the District began a five-year "Irrigation Efficiency" study in cooperation with the Research Center, by furnishing labor, material and equipment to measure on-farm inflow and outflow for about nine farms. The data collected were analyzed by USDA and U.C. Extension specialists and the results published in the "Proceeding of the 1984 ASCE Specialty Conference on Irrigation and Drainage." A copy of the paper is included in the Appendix.

f. Drain Study

In 1980, the District installed a drain sump, pump, and power line to a plot on the Research Center in the New River bottom, to study tile problems.

g. Use of Drain Water for Irrigation

In 1983, the District installed a sump, pump, 1/4-mile pipeline, and electric power to a project sponsored jointly by USDA and DWR to study the feasibility of using drain water from the Alamo River, in rotation with canal water, to grow certain crops. This is a four-year study.

h. Advisory Committee

For many years, the District has participated by having a representative as a member of an Advisory Committee to the Research Center.

4. U. C. Extension Service (Farm Advisors)

The District has cooperated with the University of California Extension Service farm advisory staff for many years, mainly by furnishing water flow and water quality data. Most recently, the District participated in the CIMIS and mobile laboratory programs sponsored by the University in conjunction with the DWR.

Discussions of water use and water requirements were held recently with University of California Extension Service personnel. Extension Service professionals in Davis, Riverside and Imperial Valley indicated their willingness to work with the District in developing and implementing a conservation plan, expecially in working with water users. District staff acknowledge the necessity of inter-agency coordination, and propose that a technical advisory group be formed right away.

H. ON-FARM WATER CONSERVATION PRACTICES

Imperial Valley farmers have been practicing conservation from the beginning of development in the Valley, both structural and non-structural. The land must be properly tiled, graded, smoothed and otherwise prepared for the uniform application of water to the crop. Over 80 percent of Imperial Valley fields have been tiled for proper drainage, a necessity for removal of excess salts from the soil root zone. About 80 percent of farm head ditches have been concrete lined. Other management practices outlined earlier are practiced by Valley farmers. The District, through its Water Conservation Coordinator, encourages use of all of these available tools and practices.

The USDA Soil Conservation District, supported by IID, offers several programs of assistance and advice. Exhibit IV.7 outlines current programs available from the Agricultural Stabilization Conservation Service (ASCS).

It has been recognized that on-farm irrigation practices are an important and integral factor in water use in the District. Grower cooperation has always been sought to improve the overall efficiency of water use.

1. <u>Land Leveling</u>

New ideas and techniques in land leveling to evenly distribute and conserve water have been utilized by many of the Valley's growers. Incentive programs such as cost sharing would increase utilization of these methods.

COUNTY COMMITTEE
[illegible]-CHAIRPERSON
[illegible]-VICE CHAIRPERSON
[illegible]-REGULAR MEMBER

COUNTY EXECUTIVE DIRECTOR
MARILYN MCABEE

IMPERIAL COUNTY ASCS FARM LETTER

IMPERIAL COUNTY ASCS OFFICE
[illegible] NORTH [illegible] STREET, SUITE [illegible]
EL CENTRO, CALIFORNIA [illegible]
TELEPHONE (619) 352-[illegible]
MONDAY - FRIDAY
8:00 A.M. - 4:30 P.M.

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

ANNOUNCEMENT

THERE ARE SEVERAL CHANGES IN THE 1985 PROGRAM. PLEASE READ CAREFULLY AND CALL THIS OFFICE WITH ANY QUESTIONS.

The 1985 ACP for Imperial County is aimed at solving the high priority conservation problems as identified by the County Committee. The County Committee would like to encourage you to consider whether you have any of these high priority problems which need solving to conserve our soil and water to reduce pollution.

THE SIGN-UP PERIOD WILL BE DECEMBER 3 - DECEMBER 21, 1984.

After the sign-up date has been closed selection procedures will be as follows:

1. The County Committee will select applications based on when the work is to be done, conservation priority and the funds available. It is not . first come first served.

2. After the selections, the applications are referred to Soil Conseravtion Service (SCS) for a needs and feasibility determination.

   WHEN YOU HAVE BEEN NOTIFIED THAT YOUR APPLICATION HAS BEEN SELECTED YOU MUST VISIT SCS AT 1285 BROADWAY, EL CENTRO WITHIN 30 DAYS, OR THE PRACTICE APPLICATION WILL BE CANCELLED.

3. If approval is given by SCS you will receive written notification from this office and you may then begin your practice.

   A PRACTICE WHICH HAS BEEN STARTED PRIOR TO APPROVAL BY THE COUNTY COMMITTEE AND SCS IS NOT ELIGIBLE FOR A COST-SHARE PAYMENT.

By law, cost-sharing is limited to agricultural producers. For program purposes, an agricultural producer is an ownwe, landlord or tenant of a farm used to produce commercially grown agricultural products, such as grain, row crops, trees, vines, livestock, etc.

THE MAXIMUM PAYMENT ANY ONE PERSON CAN RECEIVE CANNOT EXCEED $3500.00 PER FISCAL YEAR.

THE HIGH PRIORITY PRACTICES OFFERED FOR 1985 ARE:

Practice	Cost-Share
WC-4 Irrigation Water Conservation	50% of cost not to exceed $3500.00.
WC-4 Tailwater Recovery System	70% of cost not to exceed $3500.00.
SP-35 Water Management Systems for Pollution Control	50% of cost not to exceed $3500.00.

Soil Conservation Service is responsible for technical determinations. They will determine the proper depth and spacing needed to solve your conservation problems. Cost-Shares will not be approved if their recommendations are not met.

THE LOW PRIORITY PRACTICES OFFERED FOR 1985 ARE:

Practice	Cost-Share
SL-7 Windbreak Restoration or Establishment	50% of cost not to exceed $3500.00.
WC-1 Water Impoundment Reservoirs	50% of cost not to exceed $3500.00.
WL-2 Shallow Water Areas for Water Fowl.	50% of cost not to exceed $3500.00.

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

Imperial County ASCS Office
395 North 8th Street, Suite 15
El Centro, California 92243

OFFICIAL BUSINESS
Penalty for Private Use $300

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POSTAGE AND FEES PAID
USDA-ASCS
PERMIT No. 285

THIRD CLASS BULK RATE

2. <u>Concrete-Lined Head Ditches</u>

Approximately 80 percent of the farmers' head ditches have been concrete lined. The concrete head ditch saves water two ways. It reduces seepage in the ditch itself and improves the ability to manage the water in the field.

3. <u>Proper Use Of Basic Tools</u>

a. Shovel

In the hands of an experienced irrigator, a shovel is probably the most important water saving tool. The shovel and the irrigator wielding it have more influence over the efficiency of an irrigation than anything else. The shovel is used to divert and direct the stream of water to the right place at the right time, for the appropriate length of time. It is used to rebuild broken berms and build small dikes to raise the height of the water in the furrow.

b. Tablitas

Small wooden slats are used to control the stream size entering a furrow through a pipe. As the water advances down the furrow the tablita is used to maintain the even advance of the water. Once the water reaches the lower end of the field, it is cut back at the head to a lower flow. Usually by the time this cutback is made, the infiltration rate in the upper end of the field has decreased and most of the water flows to the lower portion of the field. Water that does not enter the soil by the time it reaches the end of the furrow usually flows off the field as tailwater. By reducing the incoming stream size with the tablita, tailwater is reduced and water is conserved.

c. Record Keeping

Maintenance of good records of irrigation dates, amounts applied, application rates, herbicide and fertilizer applications, cultural practice, etc., enables the farmer to plan and adminster his farming operations more efficiently. Most farmers in the Valley have good record-keeping practices.

4. Innovative Tools

a. Fasets

Fasets (variable size orifice caps Exhibit IV.8), are also used to control the stream size entering a furrow. These caps were developed by a local grower. They allow the grower to select the stream size which best fits the size of the order, field length, slope, soil moisture and texture. They can also be used to reduce the stream size applied in the wheel row.

b. C-Taps

The infiltration process can be achieved sooner by the use of dikes in the furrow to raise the elevation of the water surface closer to the seed bed, slow the velocity, and increase the wetted surface. This practice is often accomplished locally by the use of plastic or metal "taps". The plastic "C-Tap" was developed locally by a Valley grower to conserve water in his fields. They are now sold commercially in the Valley. See Exhibit IV.9.

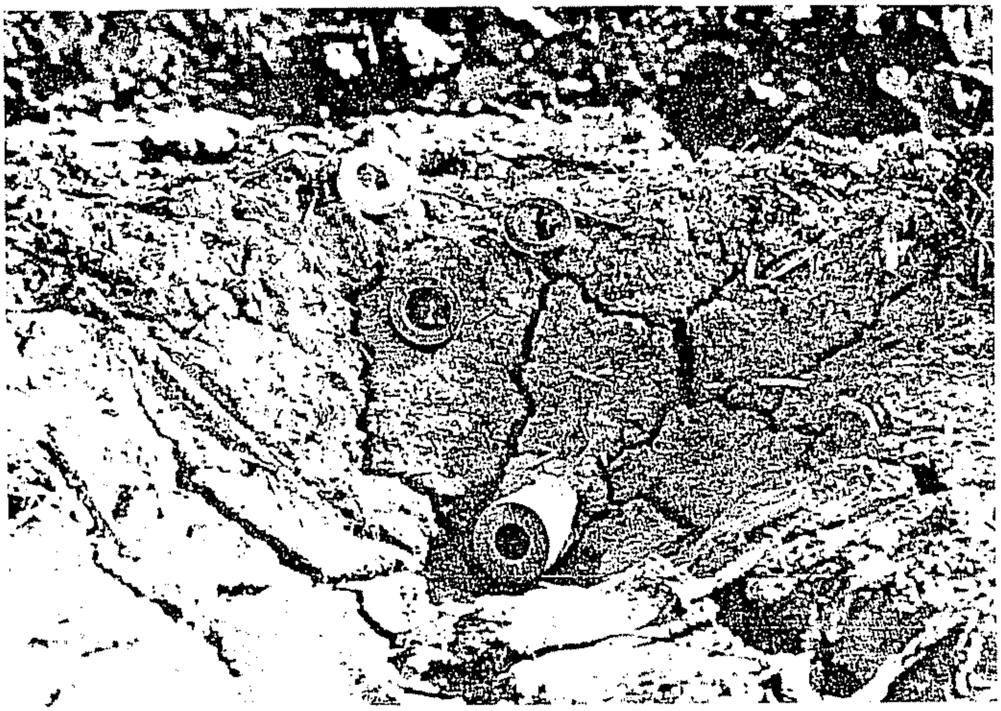
Some farmers use earth dikes protected by polyethylene sheeting or paper sacks. This practice is costly due to the extra labor needed to set the dikes and their removal before cultivation.

Another method used to accomplish the same thing is to construct a "V" ditch along the tail end of the furrows and by installing the outlets from the "V" ditch high enough to back the water up for a distance. The outlets from the "V" ditch are protected from erosion by plastic sheeting.

A farmer in Calipatria has developed a device to automatically build earth dikes in the irrigation furrow at any specified interval. It is attached to a planter or a cultivator involving no extra labor. This device is just being marketed and its use may be limited to locations where ground slopes are generally steeper than average.

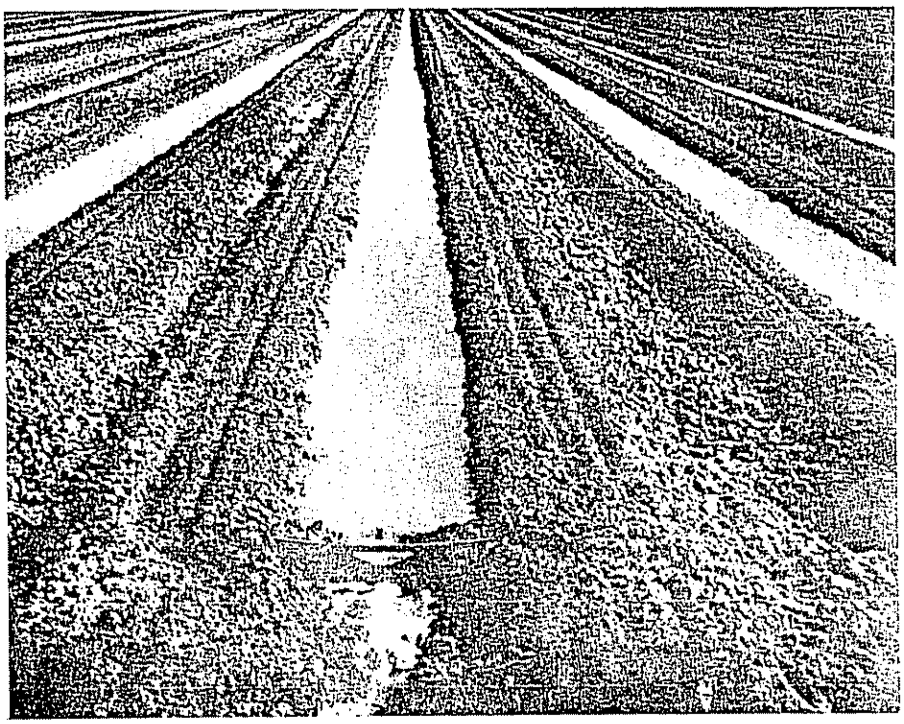
c. Moss Remover

Growth of aquatic weeds in the canals is a continual maintenance problem. The canals must be dried up regularly to kill



VARIABLE SIZE CAPS "FASETS" ARE USED TO CONTROL THE STREAM SIZE.

EXHIBIT IV.8



TAPS ARE USED TO ACHIEVE INFILTRATION AND REDUCE TAILWATER.

EXHIBIT IV.9

the moss. In addition mechanical removal of the moss is also necessary. As the sprigs of moss and other aquatic weeds float in the water they can plug up checks, delivery gates, irrigation tubes and sprinkler pumps.

Again local growers have met the challenge and have developed various methods to remove the debris from the water. Exhibit IV.10, is a picture of a hydraulically-driven moss remover. The flowing water drives the paddle wheel which drives the revolving screen. At the top of the screen bristles pull the moss from the screen and it falls onto the platform.

If the debris is not removed from the irrigation water, the siphons or tubes used to distribute the water into the furrows will become plugged and the advance of the water down the furrows will be very erratic. The results will be excess tailwater; therefore, to achieve high efficiencies, as much debris as possible must be removed from the water

Hardware cloth, placed in front of each tube, is another method used by local growers to prevent clogging. (Exhibit IV.11).

All of these methods are costly but necessary to improve water distribution and conserve water.